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REISS'S APPARATUS FOR REPRODUCING MUSICAL SOUNDS.

The apparatus devised by Reiss, we believe in the year 1861, appears to be the first for reproducing musical sounds at a distance by means of electro-magnetism. The late trial in Edinburgh of the United Telephone Company *v.* Maclean has brought forward in a very prominent way the arrangement which Reiss evidently *intended for musical sounds simply*, and not for the purpose of reproducing articulate speech. However, during the proceedings in connection with the above contest, this apparatus was held up as a prior publication to the Bell and Edison patents; and although favourable and adverse opinions were expressed as to its use as a telephone transmitter, the subject has assumed an importance that it is unadvisable to overlook, and we therefore propose to make an attempt to place the action of Reiss's invention in its right light, and to correct some misapprehensions which now exist as to whether it is really a reproducer of musical sounds only, or whether it can actually be made to reproduce articulate speech in the proper sense of the term.

The best known arrangement of Reiss may be explained in a few words. A hollow wooden box with two apertures, one at the top, the other in front. The upper hole has tightly stretched across it a membrane of bladder, vellum, &c. A mouthpiece is inserted in the opening at the front of the box. When one sings into the mouthpiece, the membrane above vibrates exactly with the vibrations of the voice. A piece of platinum plate is attached to the centre of the membrane, and has a battery wire attached. A platinum contact point presses the platinum plate and forms part of the circuit. As originally intended, when vibrations are set up by any means in the instrument, the contact is alternately made firmer and then broken altogether, these makes and breaks of course being more or less rapid according to the pitch of the sound, or, in other words, in exact proportion to the vibration set up by the voice. Without entering into a definition of the meaning or causes of sound, we may say that musical sounds, as distinguished from noises, are those which produce a *continuous* sensation and whose values can be musically determined. They depend upon three qualities—*pitch*, *intensity*, and *timbre*, or quality. It is this latter property which it is most difficult to understand. For instance, two instruments—say a violin and a flute—may each produce a note of the same pitch and of the same intensity, yet the quality of the two notes is entirely different. Two voices may also equally differ in quality, and as we have been only alluding to musical sounds, it will be readily understood what complex vibrations are set up in articulate speech, when we not only distinguish the difference in the quality of voices, but are also able to distinguish one word from another, although they may be spoken in the same tone of voice, but the shapes of which, if we may use the term, are controlled by the larynx before the vibrations enter the surrounding space.

It has been asserted that Reiss's original apparatus has transmitted articulate speech (we are not concerned at present with the kind of receiver employed), and that it can be made to do so again. This we are not prepared to deny, but probably its truth is attributable to a cause which we do not think has been yet touched upon. Now it appears to us that whenever articulate speech has been transmitted by this instrument, it was working under entirely different conditions to those intended or thought of by the inventor. When the postal authorities took action in 1880 for the purpose of establishing their claim to the telephone as a telegraph instrument, we believe numerous experiments on articulate speech were then carried out with Reiss's invention, his apparatus being used as a transmitter. Words could be distinguished at the receiving end when the transmitting instrument was spoken into in a very *gentle* tone of voice. We do not mean a low tone as regards the number of vibrations of the voice, as this might be of any pitch, so long as it was kept gentle or soft, and therefore that the amplitude of the vibrations did not exceed a certain range.

It is quite possible that the contact of the platinum point on the plate might be so adjusted, that when speaking into the mouthpiece gently, the forward motion of the membrane would produce a firmer contact between point and plate, and that the receding movement would only reduce the normal pressure, without actually breaking contact between the two at all, the result being vibrations in a closed circuit. Such a movement would produce corresponding fluctuations in the resistance of the circuit of a sufficient degree to reproduce speech; but then the action is not that of a make and break, but simply that of a "tension regulator" as described by Edison, or of the microphone of Hughes. If we examine Reiss's instrument as a make and break apparatus simply, it appears evident on the face of it that articulate speech in the proper acceptation of the term cannot be produced; for although we can have varying degrees of contact, that is to say, it may be firmer and closer at one minute interval of time than at another, we cannot have variations of make and break. Therefore as long as sounds are transmitted by makes and breaks, it is certain that although the vibrations may be reproduced in a receiver with perfect similarity as far as their number and interval are concerned, they cannot give their amplitude, and therefore, however loudly one may sing into a Reiss transmitter, when *acting as a make and break*, the voice cannot be reproduced beyond a certain strength at the receiving end. It will therefore appear plain that such an instrument can only produce one of the three necessary qualities of sounds, viz., pitch. Its waves or vibrations would always be of the same amplitude, because, although by speaking or singing into the instrument with varying degrees of loudness, we might vary the resistance of the make, we cannot have the corresponding vibration of the break qualified in the slightest degree. We may therefore conclude that when articulate speech has been manifested to any experimenter when using this apparatus, the action has been that as before described, and not a make and break. It has been attempted by many to explain the action of the Hughes microphone by attributing its powers of transmitting the human voice in articulate speech to its exquisite delicacy of

make and break. Here again we may say that it is impossible to conceive such a thing as delicacy of *make* or *break* in an electrical circuit.

Indeed, we think that one fatal objection to such an explanation of its action is to be found in the fact that in the microphone all its constituent parts are attached to the same support, and must vibrate as the support vibrates either backwards or forwards. It is therefore difficult to imagine any break taking place at any time in the Hughes microphone when properly adjusted for transmitting speech. It has been said in proof of breaks occurring, that minute sparks have been observed at the points of contact of the carbons employed. This does not prove in the least that an actual break takes place, but only that the current when passing from one carbon to another, by various paths represented by the number of points or molecules in contact, had certain of these paths ruptured, hence the sparks.

For instance, if we connect a number of incandescent electric lamps between two conductors, and break one away, we shall see a spark, but the whole circuit is not broken, but only one of the numerous paths open to the current. We may therefore safely assume that even this apparatus of Professor Hughes cannot be explained by a make and break action. It might be simply illustrated by comparing the vertical carbon pencil to a cork floating in the ocean. The cork will be buffeted about according to the amplitude of the waves, but is never thrown out of the water. So it is with the carbon pencil. It is moved or shaken about more or less rapidly and vigorously according to the number and amplitude of the vibrations produced by the voice, but we cannot imagine it leaving its connection with the other carbons. In fact, at the bottom point at any rate its own weight would be sufficient always to keep it in contact, however slight. Returning to the question of Reiss's invention, it is not our province to decide as to whether it constitutes a prior publication in the controversy now going on as to the validity of certain patents for the invention of transmitting articulate speech by electricity. It seems evident that the apparatus of Reiss may be employed for the same purpose as the Edison "tension regulator" or Hughes' microphone, but it must be by variation of *contact* only, which must not at any time give way sufficiently as to constitute a break in the circuit.

It appears clear that Reiss did not anticipate the wonderful results which he might have obtained from his simple apparatus by altering its mode of action, therefore it is hardly probable that his invention would stand in the way of a patent for other effects which he did not foresee, simply because we, with the knowledge we now possess, can adapt to a certain extent his apparatus for the same purpose.

THE TELEPHONE CASE.

(*Continued from page* 139.)

Now my lord, the question is—the invention under this claim being reduced to that very narrow point—Whether there had not been before December, 1876, a disclosure in this country of the substitution of iron plate for the membrane. We say that in September, 1876, that substitution was disclosed, and so far, my lord, there is no controversy. There was an instrument described and exhibited by Sir Wm. Thomson at Glasgow which contained all the features of the instrument now claimed, with this difference, that the metal plate in place of being fastened down, was, as shown in the model, standing up more or less, or not fastened down. Now the whole case of the complainer rests upon that—upon the metal disc not being fastened down, but standing up. If the disc had been shown by Sir Wm. Thomson, or in the drawings in *Engineering*, as fastened down, the case would have been at an end, and that would be the very instrument, whether it works well or not, which is claimed in the first claim. But, then, it is said that there was a valuable discovery, that the merit of the invention was in the fastening down to the instrument the lid or disc. I say, my lord, that that was not an invention. It was not a subject matter for a patent. and for this reason that the holding of the lid down was under the circumstances an absolutely immaterial thing, seeing that so soon as the instrument was at work the holding down was effected as matter of necessary result. You cannot have a patent for an improvement which arises by way of necessary result, and which any person making or using the instrument would effect for himself, and quite as well, and virtually in the same manner. Just suppose that anybody reading the description in *Engineering*, or hearing Sir Wm. Thomson's lecture, had desired to make a telephone receiver on terms of the instrument described by Sir Wm. Thomson, what would he have done? In the first place he would have gone back to Bell's publication which is printed and to which I need not refer again, which explains how the instrument is to be connected with the battery, what amount of resistance the instrument should have, and what amount of electric force is required to deal with that resistance. He would then have constructed the instrument with a lead stick put as shown [model exhibited], and he would then, following Bell's directions, have taken a five-carbon battery and set the machine going. Of course if he used a machine like this where the resistance is 1,450 ohms, he would require a very powerful battery; but if he took a machine like Bell's, with 25 ohms—25 measures of resistance—he would require a much lighter battery. My friend represents that the description in Bell, to which reference has so often been made, and which is in the print, referred to the membrane telephone. Of course that is so, and it is shown in the article in the *Journal of Telegraph*, August 1st, 1876, "Researches in telephony." My friend is quite correct in saying that Bell is dealing with the membrane diaphragm; but in this matter of the force of the current the one principle was quite as good a rule, for the iron disc and the proportion must be preserved. The article says; "Two single pole electro-magnets, each having a resistance of 10 ohms, were arranged upon circuit with a battery of five carbon elements, the total resistance of the circuit was about 25 ohms." Taking that proportion any person could have constructed an instrument something like this, and could have used a battery of five carbon elements, and what would nave been the result? The moment the electric current was applied down would come the lid. It is true that when you took the same battery and applied it to this instrument [produced], the lid would not be held down, but that was just because this instrument, from its larger size and other circumstances connected with its resistance, required a greater degree of electric force than a smaller one; but that is a subject for arrangement which an electrician would have no difficulty in adjusting. Mr. Morgan-Brown claims this as his improvement. Now, it comes to this, that there can be no patent for an improvement which is a mere declaration of a necessary result, and it is of no moment whether this worked or not, or whether it worked well or not. So far as the evidence goes this instrument works as well as any instrument ever made in terms of plan 4. But supposing for argument's sake that you are at liberty to use a receiver of that description, attached only at one point and held down by a magnet—that is not the instrument described in Morgan-Brown's patent. The question is whether there is such a merit in the invention of holding down by wood what is necessarily held down by the magnet. The improvement is really this: I will effect by wood nippers what the magnet affects automatically when the instrument is at work. I submit that is not enough to warrant a patent. Something has been said about the attempts to construct the instrument. Why did not Mr. Cooke, or somebody else, make a successful working instrument? My lord, the time after all was only three months. The article in *Engineering* was not published till after Morgan-Brown's patent came out. The truth was that, Sir William Thomson having given the public the information, Mr. Morgan-Brown was too sharp for anybody else, and he produced the patent for it within three months after Sir William made the publication. The point depends on the state of prior knowledge. I start with a certain state of prior knowledge, which shows that the invention existed up to a certain point, and that this was an improvement—the substitution of an iron for a membrane disc. That is all that is claimed. This improvement was disclosed of substituting a metal disc. Is there room for a further patent, which was to consist of a further improvement by holding it down by wood, seeing that the machine itself holds it down as soon as it is put into operation? There is no contribution to the stock of knowledge in informing the public that they may do with wood what will be as well done without the use of wood, and by the instrument. Mr. Salvesen further points out that really when Morgan-Brown came to specify, he did not specify how it was to be fastened. It is implied, no doubt, because you may gather from the drawings that it is to be fastened; but really the communication given to the public by Morgan-Brown was in all material respects the same as that given to the public by Sir William Thomson. You must have a material contribution to public knowledge; and it is for your lordship to say whether that material contribution was given by a man who simply said fixing down by wood what was already fastened down by its own action. In conclusion, it all turns upon the absence of a successfully manufactured instrument during these three months. Sir William Thomson has been asked why this instrument did not speak, although a similar instrument was speaking in America; and though there may have been some defect in the instrument he did not seek to construct another form of instrument and make his experiments with that. If he had he would have made an instrument like this model, and it would have spoken at once, and it would have done as well as Morgan-Brown's. I think I have now exhausted the case; I must have exhausted your lordship, and I know that I have exhausted myself.

MR. MACKINTOSH: That his lordship would understand that Mr. Maclean merely bought the instruments in the open market, he was not the maker.

LORD M'LAREN: So that he will not be responsible personally. His lordship added that he would take time to consider his judgment.

The Court then rose.

WEDNESDAY, FEBRUARY 1.—LORD M'LAREN to-day gave judgment in the case of the United Telephone Company *v.* Maclean. Parties having been called, and Mr. Dickson appearing on behalf of the complainer, and Mr. Salvesen for the respondent—

HIS LORDSHIP said: In this case interdict is sought at the instance of the United Telephone Company against the infringement of two patents for telephonic instruments; the first being the original telephone invented by Mr. Graham Bell, and patented in this country in the name of Mr. Morgan-Brown; the second being the transmitting instrument invented by Mr. Edison, and patented in his own name.

The title of the complainers to these patents is set forth in their statement of facts, and is not denied. The question is, whether the instruments which, according to the evidence, were supplied by the respondent to a professional firm in Edinburgh, constitute an infringement of the complainers' patents or either of them? Specimens of the instruments sold by respondents were produced at the trial, and their action explained. It is alleged that the respondents use Edison's transmitting instrument, and Bell's receiving instrument. With respect to Bell's invention the defence is, that the patent was anticipated by the premature publication of the invention before the letters-patent were taken out. With respect to Edison's patent, there are two defences: (1) an objection to the patent itself, founded on an alleged discrepancy between the provisional and the complete specifications; (2) a denial that the respondents' transmitting instrument involves the use of Edison's invention. I shall deal with the cases in the order of discovery, beginning with the invention of Mr. Bell.

The specification of William Morgan-Brown, in which this invention is described, is divided into various "plans," which contain respectively the descriptions of different instruments, or different variations of the same instrument, adapted for the transmission and reproduction of vocal sounds through the agency of the electric force. But the only instruments or modes of application of Bell's invention referred to at the trial were the instrument described in plan fourth, and the two instruments or modes of application which are described in plan fifth. These three variations of Mr. Bell's invention, as I shall call it (because it is not disputed that he is the first and true inventor of the telephone), are described with great clearness and fulness of detail in the evidence of Sir Frederick Bramwell, C.E. Under reference to this description, which I accept in all its particulars, I shall state as briefly as may be the essential parts of Mr. Bell's invention, and shall consider whether the invention is disclosed by the alleged anticipatory publication with such distinctness as would be necessary to enable a person of skill to make the instrument, and to put into effective operation.

The essential parts of Bell's invention appear to be (1) a tympanum or circular plate of steel, or other metal susceptible of inductive action, for receiving the air pulses or undulations of speech; (2) the transmission in a closed circuit of electric undulations of the same order, induced by the vibration of this metal plate or tympanum; (3) the production of a repetition of the spoken sounds at the distant station or termination of the line wire by means of another metal tympanum, which, through "induction" or electric agency, is made to vibrate in the same manner as the first-mentioned tympanum, and thus to reproduce the vocal sounds in fac-simile. All the witnesses are agreed that, under Bell's process, the transmission of the electric undulations along the wire is continuous. These undulations represent variations of the electric current corresponding to the variations of the elastic medium thrown into vibration by the voice, and like these they are continuous, because the electric force is transmitted from one station to the other in a closed circuit continuously, and without break or interruption; this is, in truth, the principle of Mr. Bell's invention—the transmission of undulatory electricity in a closed circuit. Prior to this invention, attempts had been made with partial success to reproduce musical sounds by different methods. By delicate mechanism, which it is unnecessary here to describe, the vibration of a tuning-fork or a musical string was made to alternately connect and disconnect two points in an electric circuit, and thus to send on a series of uniform and separate pulsations, by which a string tuned to the same pitch could be made to vibrate at the distant station. The most perfect modification of this process is that known as Reiss's invention, by which the sound was received on a drum of gold-beater's skin or membrane, carrying an armature or steel needle capable of inducing electric action in the line wire. By this means musical notes and vowel sounds were reproduced. It is clear, however, that by Reiss's method spoken discourse could not be conveyed from one station to another; and for this reason, that his instrument acted by transmitting a series of discontinuous electric impulses resulting from the alternate making and breaking of the circuit, and was therefore not adapted to the transmission of a continuous and variable series of undulations, such as are produced in articulate speech.

Mr. Bell discovered that electric undulations resembling those produced by speech could be transmitted through a closed circuit, and his specification (Morgan-Brown's) describes different instruments and modes of operation for producing this result in a manner which is admitted to be clear and intelligible. It is also established that telephones constructed according to Bell's method were extensively used and were of great utility.

I now come to the alleged anticipation of the invention through the publicity given to Bell's discovery by Sir William Thomson, in his address to the British Association, delivered in August or September, 1876.

Sir William Thomson, in his evidence in this case, stated that he was present at the performance of Bell's experiments on the occasion of a visit to the International Exhibition at Philadelphia, and tha the heard the instrument repeat the phrases of Hamlet's Soliloquy, which he quotes in his address. Mr. Bell, treating Sir William Thomson with the confidence accorded to a scientific visitor of distinction, had shown him his apparatus, explained to him the principle of his invention, and presented him with models or copies of his transmitting and receiving instruments. Sir William Thomson, in the passage of his address to the British Association, which has been reprinted from the newspaper called *Engineering* of 15th September, 1876, gave an account of Bell's discovery, and he also exhibited models of Bell's transmitting and receiving instruments. The object of the learned lecturer, however, apparently was to describe results rather than processes; and although inferentially he may have given some indication of the methods employed, I am satisfied that his address does not contain such a description of Bell's process as would, even with the aid of the models, enable a skilled operator to produce a working telephone on the principle of the specification. Such is the opinion I have formed, construing the passage in Sir W. Thomson's address, as I should construe a specification, after informing myself as to the state of scientific knowledge on this subject at the time, and with all the aid which I have been able to derive from the evidence as to the meaning of the terms of art used in the address and their application to the models.

It is plain that the invention had not been perfected—was, indeed, only in the experimental stage at the time when Mr. Bell explained his method to Sir William Thomson, and Sir William in his address did not profess to communicate anything more than he had received from Bell. Mr. Cooke, a witness for the respondent, thinks that he could have made the instrument from Sir William Thomson's description. But then Mr. Cooke is an electrician of more than ordinary skill; and against his view I have to set the statement of another electrician of not inferior skill, who, with superior advantages to those of Mr. Cooke, tried to produce articulate sounds with Bell's instrument, and failed. Besides, I must say that Mr. Bell's experimental instrument, as published by Sir William Thomson (if the address is held to amount to publication), differed most materially from the instrument as patented. First, the transmitting tympanum of the experimental instrument consisted of a stretched membrane or drum, carrying a steel armature. All the witnesses are agreed that such a tympanum is open to serious objection, and that it will not give results satisfactory or comparable to those given by a metal transmitter, as described in the specification of the patented invention.

Secondly, the address does not state that the transmission of the electric force is to be made through a closed circuit, although this, as I have endeavoured to explain, is really the principle on which the successful working of the invention depends. It is true, Sir William Thomson did not profess to describe any mechanical appliances for making and breaking the circuit; but it does not follow that his audience would draw the inference that the circuit was to be closed. He was not professing to give a full description of the mechanical appliances used by Bell. Nobody but Sir William Thomson and Bell himself knew that the transmission of the electric current was to be in a closed circuit, and yet the skilled operator, who is supposed to be able to work, from Sir William Thomson's description, is left to find this out for himself. How was he to find it out, unless by the exercise of inventive talent; by, in short, re-discovering the principle of Bell's invention?

Thirdly, the plate, or the tympanum, of the model-receiving instrument exhibited by Sir William Thomson, instead of being attached to the transmitting case by its circumference, so as to imitate the form of a drum, was attached by a screw at one point only, as shown in fig. 11 of the respondent's print of prior publications. While thus attached, it stood inclined at an angle to the mouth of the case, like the lid of a box slightly raised. In this position the plate would vibrate in the manner of the tongue of a tuning-fork, and not in the manner of a tympanum. According to all the evidence, such a receiving instrument would not repeat articulate speech.

This brings me to the decisive part of Sir William Thomson's evidence. This gentleman, himself the most eminent electrician in the United Kingdom, possessed of the instruments furnished by Mr. Bell, and instructed by Bell as to their principle and mode of application, was unable to make them work so as to reproduce articulate speech. He was most anxious to exhibit them in effective operation at the meeting of the British Association, and after trying them with batteries of different degrees of strength, and with every variation that his experience suggested, his experiments entirely failed, and he was obliged to admit his inability to exhibit the telephone in operation. The respondent suggests, that if the tympanum or lid had been less rigidly attached by its screw, it would have closed down under the attraction of the electromagnetic force, and would then have acted as a closed tympanum capable of transmitting articulate speech. To this there are several answers. First, this is a suggestion easily made, after the principle of the closed tympanum had been made public through Bell's specification. Secondly, Sir William Thomson's lecture, with the relative model, disclosed a receiving instrument with an open, and not a closed tympanum. Confessedly such an instrument would not reproduce articulate speech, and if the specification had given no more information on this head than is given by the model, I should have held the patent void, as not sufficiently disclosing the manner of performance of the invention. Thirdly, as to the suggestion that a skilled operator would have found out the mode of operation when he came to use the instrument, I may observe that, according to patent law, an invention is not sufficiently described if experiment be requisite to enable a skilled operator to discover the mode of working it: and, after being told by Sir William Thomson that his scientific knowledge, aided by personal communication with the inventor, did not lead him to infer that the tympanum should be kept down in order to the production of the desired result, I cannot for a moment suppose that this inference is one that should be drawn by an ordinary workman working by the description contained in Sir William Thomson's address.

I shall say nothing as to the other publications contained in the respondent's print. The last in the order of dates was published after the date of the patent. The other publications are less specific than Sir William Thomson's address, and were founded on by the respondent's counsel rather as evidence of the state of scientific knowledge at the time, and in aid of Sir William Thomson's address, than as independent disclosures of the invention.

II. I pass to Edison's patent: and first, as to the objection founded on the discrepancy between the provisional and the complete specifications. The complete specification describes various telephonic instruments, and, amongst others, an instrument known as the phonograph, which records the undulations of a vibrating diaphragm or tympanum, by indenting a series of dots on a cylinder, covered with tinfoil, and made to revolve rapidly by clockwork. In the reverse or complimentary action of the instrument, the sounds may be reproduced with more or less distinctness, by giving to another diaphragm the motion resulting from a steel point vibrating in contact with the

series of indentations. The description will be found in the paragraph commencing at page 11, line 5, of Mr. Edison's specification. The invention includes two processes—first, the recording of the sounds on a sheet of tinfoil; secondly, the reproduction of the sound by means of mechanism set in motion by the indentations on the tinfoil. It is said that the provisional specification discloses only the first of these two processes; and that the patent is void, because in the complete specification the reproduction as well as the recording of the sound is claimed. This is an extremely critical objection, and I do not think that it is well founded. The provisional specification states (pages 1 and 2), "Portions of the apparatus are interchangeably available in transmitting or recording;" and two lines further down the word "recording" is explained to mean making a record of the atmospheric sound waves, or of the electric waves or pulsations corresponding thereto or resulting therefrom. Now, keeping in view that in the telephonic art the words "transmitting," and "transmitter" are technical terms applicable to the part of the instrument by which the speaker's voice is made to set the electric wave in motion, I think that the expression "interchangeably available in transmitting or recording" is for the purpose of a provisional specification a sufficient indication of the functions of the phonograph. In the application of the instrument to the purpose of recording, the sound waves are laid down on the cylinder by the steel point attached to the tympanum, and vibrating with it. But by the same apparatus the action of transmitting may be produced—the indentations on the cylinder in this case acting on the steel point and causing the tympanum to vibrate, and thus to transmit electric undulations to a line wire. The words "interchangeably available" may be open to criticism, but they indicate an instrument in which the same mechanism may be used either for recording a message, or for transmitting one which has been recorded.

III. There remains for consideration the question of the identity of the respondent's transmitting instrument with the transmitting instrument described in Edison's specification—a question of some difficulty, though I have ultimately formed a clear opinion regarding it. In the Bell telephone the electric undulations set up in the line wire were comparatively weak, and the echo or reproduction of the voice at the distant or receiving station was correspondingly faint, so faint that the telephone could only be used within moderate distances. Mr. Edison's efforts were directed to the discovery of a method by which the waves of sound should operate more powerfully on the electric current, and this he effected by a process which is described by electricians as the method of "varying the resistance" to the electric current in the course of its transmission through a closed circuit. This was accomplished by making a joint in the circuit near to the transmitter, so that the current should at this point pass from one surface to another surface in contact with it under pressure. According to Mr. Edison, one of the two surfaces in contact ought to be a semi-conductor; and plumbago and some other forms of carbon are indicated as the most suitable materials for the purpose. According to his description, the variations of pressure between the surfaces, consequent on the vibrations coming from the tympanum, induce variations in the electric current proportionate to, but greatly exceeding in magnitude, the variations which would be induced by the direct action of the air waves according to Bell's method. According to Edison's theory, his process is in the strictest sense a mode of working in a closed circuit, because the carbon surface, although mechanically disunited from the platinum or other surface on which it presses, is nevertheless in electrical contact with that surface. There is therefore no making and breaking of the electric circuit as in the earlier tentative methods, but a continuous current of undulatory electricity, the number and form of the waves being determined by the changes of pressure upon the carbon surface.

In the first form of apparatus figured in the specification the semi-conducting interposed substance (technically termed the tension regulator) is silk fibre mixed with plumbago. This is pressed by a screw against a platinum plate, which again is in contact with the tympanum, and the elasticity of the tympanum and of the silk fibre admits of that degree of play between the two surfaces which is requisite for the transmission of the variations of pressure produced by the vibrations of the tympanum when acted on by the voice.

In a passage near the top of page 6 the inventor describes an alternative mode (on which the complainers place reliance), wherein he professes to make use of a variable resistance (*i.e.*, to the electric current), resulting from greater or less intimacy of surface contact, such as would result from a disc covered with plumbago placed adjacent to a diaphragm also covered with plumbago or other semi-conducting material. It is not stated in direct terms how this form of tension regulator is to be connected with the transmitting instrument; but, in fair construction, I think it must be held that it is to be introduced in the place of the silk fibre, and to be kept in contact with the diaphragm by pressure, just as the fibre regulator would be.

Other modes of maintaining the contact are described in subsequent parts of the specification, in one of which the pressure of a spring is employed.

It does not appear that any of the mechanical combinations described in the specification ever came into commercial use, probably because, as may happen in the history of even the most original and valuable inventions, these were immediately superseded by simpler constructions involving the same principle. It was soon found that no special precautions were needed to prevent the separation of the surfaces constituting the tension regulator. I am informed that Mr. Edison now uses a carbon button placed between two plates of platinum, without the agency of a spring or mechanical pressure to hold them together. In the respondent's instrument, against which the interdict is directed, the variations of resistance to the electric current are produced by the contact of two surfaces of gas carbon, one of them being loaded with a piece of brass, and suspended obliquely, so as to press slightly against the other. To these pieces wires are attached, and the current passes through them. This is said to be a different instrument from Edison's both in principle and construction. It is said that Edison aimed at varying the resistance in the line by the compression of fibrous material throughout the mass, and not by the vibration of pressure at the surface of contact. Again, it is denied that the operation of the respondent's instrument depends on pressure. It is said that in his instrument the two carbons react on each other in the manner of rigid, non-elastic, incompressible substances, and that, instead of the electric current being merely varied, under the influence of vibration, as the surfaces of carbon tend alternately to approach and recede from each other, the electric current is actually broken at each vibration. According to the respondent's theory his instrument is not an example of the action of undulatory electricity in a closed circuit, but is an extremely delicate "make and break" of the current, so delicate and instantaneous (if I rightly understand), that the undulations are virtually, and in their acoustic effects, equivalent to continuous vibrations.

It would probably not be satisfactory to the parties if I should abstain altogether from offering an opinion on this interesting scientific question. But I think it right to say at once that, in the view I take, its solution cannot affect the decision of the case. Because, in my opinion, it is apparent, at least in the present state of scientific knowledge, that the principle and mode of action of Edison's tension regulator and that of the respondent is one and the same. If the respondent's surfaces vary the resistance by a "make and break," so must Mr. Edison's. Nothing is more clear upon the evidence than that the wonderful and hitherto unexplained responsive action of the electric force to vibrations propagated through surfaces in loose contact, depends neither on the form of the surface nor on the mode or amount of pressure, although some forms of contact and of pressure certainly give better results than others. Mr. Edison's methods have this in common with the respondent's—that they produce similar phenomena under every mode of bringing semi-conducting surfaces into contact in an electric circuit, and until some distinction is shown to exist, similar phenomena must, in my opinion, be referred to one and the same general law. Even if Mr. Edison were held to be in error in supposing that his method was that of a closed circuit, yet if it is a useful invention, and if it is sufficiently described for practical purposes, it is no objection to his patent that he has used language which would be scientifically inaccurate according to the present state of knowledge.

While, for these reasons, I hold that, in any view of the mode of action, the principle of the respondent's instrument is identical with Edison's. I must also hold that the weight of the evidence is in favour of the accuracy of Edison's description of the principle of his invention as being that of a closed circuit.

Sir F. Bramwell and Sir William Thomson are strongly of opinion that articulate speech cannot be, and is not under any of the instruments referred to, produced by a make-and-break arrangement. According to these gentlemen, the elastic waves of sound passing through two surfaces in contact produce phenomena analagous to those produced by the collision of elastic bodies. The surfaces in contact are slightly altered in form by the sound vibrations—passing through alternate phases of greater and less convexity, or of expansion and compression. These changes are understood to be molecular, and do not involve any visible change of figure, such as may take place under mechanical or forced vibration. During the phases of compression, there are a greater number of molecules of the respective surfaces in contact than in the phases of expansion, and the transmission of the electric force at each vibration is supposed to be proportional to the number and extent of the molecules or minute surfaces in contact. To the objection that carbon (the most sensitive material for this purpose) is not a highly elastic body, the reply is that carbon is sufficiently elastic for the purpose of transmitting the sound vibrations, and that its suitability to this purpose depends on it being a semi-conductor of electricity. A good conductor would transmit the force too easily when the pressure was withdrawn. But it is the property of a semi-conductor that its power of transmitting the electric force varies considerably under varying conditions of pressure, and Edison's invention consists in taking advantage of that property by appropriate appliances. Professor Fleeming Jenkin, a most accomplished electrician and of very great experience, does not differ from Sir F. Bramwell and Sir William Thomson in his view of the mode of action of the carbon regulator. All these gentlemen are agreed, that when the surfaces are separated even in an infinitesimal degree, there results an irregular instead of an undulatory variation in the electric current, producing a buzzing sound and interfering with the acoustic action of the instrument. This result may follow even from speaking in too loud a tone, and it has been found necessary to moderate the vibrations of the tympanum of the telephone by introducing cork between its surface and the carbon regulator, in order that its action may not be so strong as to cause the carbon surfaces to separate under vibration.

Another point urged for the respondent is, that under his instrument a tympanum is unnecessary, because the carbon regulator, or microphone, as he prefers to term it, is sufficiently sensitive to be acted on by the direct pulsations of the air. Now, as Edison's patent is for a tension regulator in combination with a diaphragm or tympanum, it follows that the interdict sought would not apply to the use of the respondent's carbon regulator without a tympanum. But, in the instruments sold by the respondent, the sound is transmitted across a circular metal disc, interposed between the mouthpiece and the carbon regulator, and although this metal disc is mounted on a sheet of cork, I have not the smallest doubt that it acts as a tympanum, and that it is a useful and necessary adjunct of the acoustic apparatus. The cork does not prevent the metal plate from being thrown into vibration by the voice; and it transmits the sound waves, possibly with some diminution of intensity and suppression of superfluous vibrations, to the carbon regulator, whose function it is to react upon the electric circuit. It was contended by the respondent'

counsel (if I rightly understood) that the cork plate would have the effect of entirely stopping the waves of sound; but this proposition appears to me to be untenable, in view of the well-known fact that sound waves are transmitted through the earth over distances measured by hundreds of yards, or even miles, traversing in their course substances of the most various density and elasticity.

Being satisfied that the respondent's instrument is an application of the principle of Edison's tension regulator, and that it involves the combination of a tension regulator with a tympanum, I have only to consider whether the instrument is itself distinct from anything described by Edison, or is an imitation or mechanical variation of his invention.

In answering the question, it must be observed that Edison's patent is not for a specific instrument, but for a combination, in which the material element is an "electric tension-regulator," of which many forms are given, all depending on a mode of action of great simplicity, and capable of being indefinitely varied. The mode of action I take to be this: The variation of the electric current by pressure applied to a carbon surface—not the constant pressure of a screw or spring, which is a mere accident of the arrangement—but the elastic pressure of the sound waves, which are made to operate upon the carbon through a tympanum. In such a case, it may well be said that the instrument admits of as many variations as there are modes of bringing two surfaces into contact. But however unlike any particular variation may be to those which are described in the specification, yet if the contact is that of a semi-conductor of electricity, and is used in a telephone for the purpose of varying the resistance to the electric current in the line, I am of opinion that it is a form of Mr. Edison's invention, and that the words of the specification are broad enough to cover it.

In the particular case the respondent's form appears to possess such merit that it might have been patented as an improvement upon Mr. Edison's tension-regulator; but that, of course, would imply that it could not be used without Mr. Edison's licence. It follows from this opinion that the complainers are entitled to protection by interdict under Edison's as well as Bell's (or Morgan-Brown's) patent.

Mr. C. S. DICKSON, for the complainers, said: There is another matter which probably does not concern the respondent in this case, but there are infringers in England, and under the Patent Act, once the validity of the patent is challenged the patentee is allowed to obtain costs as between agent and client. The section I refer to is Section 43 of the Patent Law Amendment Act, 1852, which provides —"In taxing the costs in any action in any of Her Majesty's Superior Courts at Westminster or in Dublin, commenced after the passing of this Act for infringing Letters-Patent, regard shall be had to the particulars delivered in such action, and the plaintiff and defendant respectively shall not be allowed any costs in respect of any particular unless certified by the judge before whom the trial was held to have been proved by such plaintiff or defendant respectively, without regard to the general costs of the cause; and it shall be lawful for the judge before whom any such action shall be tried to certify on the Record that the validity of the letters-patent in the declaration mentioned came in question; and the Record, with such certificate being given in evidence in any suit or action for infringing the said letters-patent, or in any proceeding by *scire facias* to repeal the letters-patent, shall entitle the plaintiff in any such suit or action, or the defendant in such proceeding by *scire facias*, on obtaining a decree, decretal order, or final judgment, to his full costs, charges, and expenses, taxed as between attorney and client; unless the judge making such decree or order, or the judge trying such action or proceeding, shall certify that the plaintiff or defendant respectively ought not to have such full costs: Provided always that nothing herein contained shall affect the jurisdiction and forms of process of the Courts in Scotland in any action for the infringement of letters-patent, or in any action or proceeding respecting letters-patent hitherto competent to the said courts." Of course any such certificate would not affect further procedure in Scotland, but we are informed by the solicitors of the patentees in England that some certificate from your lordship would be valuable for infringement in England.

LORD M'LAREN: It is not a matter of jurisdiction, but of form of process.

Mr. DICKSON: I do not see that it can do any harm to grant such a certificate here. Whether it would be available in England I do not know, but the patentees think it might be. If it were that such a certificate could be given effect to by the English courts, then it is only fair, having regard to the provisions of the English statute, that the patentees should have it.

LORD M'LAREN: The only question is, whether the obligation to grant a certificate applies to the Court of Session.

Mr. DICKSON: I quite concede that it may not.

Mr. SALVESEN, for the respondents: I do not know that I have any interest to object, but I should suggest that judgment there means final judgment; and until your lordship's judgment becomes final judgment, the certificate should not be given.

LORD M'LAREN. There is no identity of interest between you and any other infringer, supposing the question were raised in England?

Mr. SALVESEN: No, my lord.

LORD M'LAREN: I am inclined to think that if the certificate is to be granted it will be by myself rather than by the Inner House, because the intention is that the Judge who has heard the evidence shall consider whether the whole question of the validity of the patent has been raised at the trial, and that he is likely to be better able to determine than the Court of Appeal. In this case I consider that the validity of both patents came into question on the grounds of prior publication and the insufficiency of specification; and I suppose that the theory of the statute is that where a patent is challenged it is the duty of the persons challenging it to bring forward all petitions at once. I will consider the matter, however.

Mr. DICKSON asked for expenses, which the Court allowed.

(Concluded.)

ON PHOSPHOR BRONZE FOR TELEGRAPHIC AND TELEPHONIC TRANSMISSIONS.

IN the last number of *l'Electricien* appeared a notice on the employment of wires of phosphor bronze for overhead telephonic transmission. We feel it our duty to return to this subject, as the question appears to us to be one of very great interest, and besides we have to add a few remarks to what has been already said, and also a few corrections. In a conference held on this subject at the International Congress, we said that we hoped to succeed, with the help of improved processes of manufacture, in imparting to phosphor bronze wire a conductibility greater than that till now possessed by it, at the same time preserving its maximum of resistance to fracture. Our opinions were well-founded. The wire, covered with a layer of oxide, which we call magnetic, gave in fact the following comparative results:

Our representative for France, M. Vivarez, formerly a student at the Ecole Polytechnique and at the Ecole des Mines, has quite recently tested, at the laboratory of the Société Générale d'Electricité the wires prepared in this manner. A wire, one millimetre in diameter and 100 metres in length, gives a resistance of 6 ohms. We see therefore that these phosphor bronze wires have an electric conductibility equal to $\frac{1}{3}$ that of copper, and 2·6 times as great as that of iron.

This wire is therefore far superior to that tried by MM. Nystrom and Rothen, concerning which we wrote in the last number. The phosphor bronze wires have an electric conductibility equal to about $\frac{1}{5}$ that of copper and 1·5 times as great as that of iron. (*L'Electricien*, 15th Dec.)

Although the conductibility is thus considerably increased, the liability to break does not vary. This is a consideration of the highest importance. This great tenacity allows, as we know, of a considerable reduction in the number of supports, and we can, besides, make them much lighter.

When we require to suspend over one roof as many as 400 or 500 wires, it stands to reason that the question of supports is one of importance. With the certain extension of telephonic lines and the increased number of wires resulting therefrom, if we had recourse to iron or steel, the effect produced would be far from artistic, and certainly objections would be raised against towns being darkened more than they are at present. From this point of view, a great service has been rendered by avoiding, as far as possible, fractures, which are highly probable with a collection of wires of large diameter, and which could not but be dangerous.

It has unhappily been shown in England, some time ago, that the breaking of iron wires of large diameter can cause death. Such dangers are much less to be feared with wires of phosphor bronze, which, even if they happened to break, would act as a spring, coiling up to the posts.

In cold countries snow soon collects on wires of moderate thickness. Wires of No. 8 gauge, such as are used in Scotland, Sweden, Austria, Hungary, &c., present little surface for snow, and as their tenacity and conductibility are quite sufficient, there is no need to use thicker wires, which would be more expensive and would become, like steel and iron wires, although in a less degree, dangerous in winter.

This leads us to speak of the variation of the conductibility with the temperature.

It is shown, from the experiments made by M. Mathiessen and described in the *Philosophical Transactions* of the Royal Society of London, that the variation of the conductibility, K, with the temperature, t, can be represented by an equation thus:

$$K = a - bt + ct^2,$$

in which a, b and c are positive constants, but b is already a small number, and c is at least 100 times smaller than b for the different metals and alloys tried by M. Mathiessen. If this equation is represented by a curve, the abscissæ showing the temperatures and the ordinates the conductivity, we have a parabola the concavity of which is turned towards

the positive part of the axis of y. The lowest point of the curve is given by the formula—

$$\frac{dk}{dt} = -b + 2ct = o,$$

whence—

$$t = \frac{b}{2c}$$

a rather high temperature, which gives for the minimum of conductibility—

$$K = a - \frac{b^2}{4c}.$$

In short, this value of K is very near to a, but we shall in future give, for each country, the mean value of the conductibility for the mean temperature of the country.

We may now say that the experiments which we have made up to the present, and which we shall continue with the greatest attention, allow us to think seriously from this time forward of using wires of phosphor bronze for overhead telegraph lines.

We might say much more on this subject, which has now become so important, but we do not wish to tire the reader b ya too lengthy account of the observations which we have made personally at our own works as well as in all parts of Europe where the phosphor bronze wire is used.

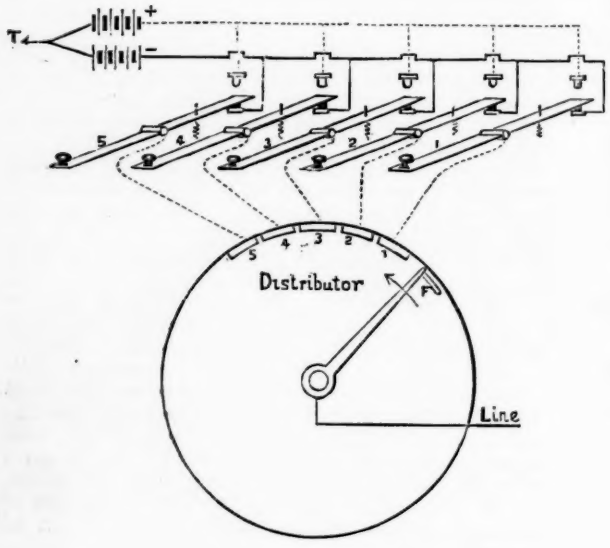


FIG. 1.

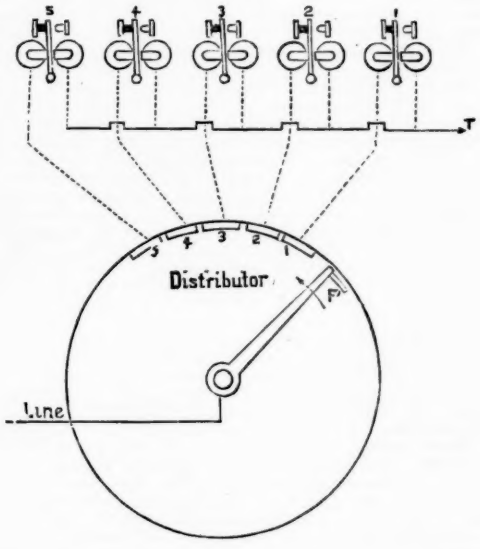


FIG. 2.

Let us conclude, however, by expressing a hope that we shall soon see the ideas of M. Marcel Deprez take a tangible form. When the transmission of force to a distance by electricity becomes an accomplished fact, phosphor bronze will play an important part in it. It will be used for the transmission of force. Dynamo-electric machines will be required, with vertical rotation, for which it will be necessary to use pads, resisting the friction, and not easily heated —in a word, pads of phosphor bronze.—*L'Electricien.*

LAZARE WEILLER.

THE BAUDOT TELEGRAPH.

THE telegraphic apparatus shown at the Exhibition of 1878 by M. Baudot has been improved in a very remarkable manner since that time. At the Electrical Exhibition for this year was to be seen a specimen which served to transmit despatches between Paris and Bordeaux.

Six employés work simultaneously on the same wire and quite independently of one another; each one by pressing the keys of a board transmits the message placed before him, which is reproduced at the other end on a special slip for each operator in printed characters, that is to say, ready to be delivered to the person to whom it is addressed. At first sight we can say that this apparatus does the work of six others, which sufficiently explains the favourable reception accorded to it.

What is really the great desideratum in telegraphic industry? It is that satisfaction should be given to the public both as regards the system of working and the scale of charges.

What is desired as regards the system is rapidity of transmission; a wire capable of good delivery without preliminary delay furnishes the solution of this problem.

A low scale of charges will result from economy in expenditure, or, what amounts to the same thing, a better utilisation of material. The Baudot apparatus, which effects with a single wire six times as much work as any other, makes a great step in the progress of telegraphy.

Before describing this apparatus we will make a short digression on the subject of telegraphic transmission by means of electric currents in order to show the relation of this new method to the preceding systems. Already the whole world is included in this special domain of electricity called the telegraph.

The signs transmitted by the wire result from interrupted emissions following a certain rhythm. There is a great deal of discussion as to the real nature of these emissions; are they merely undulations or really a flow of matter? We shall not touch upon this question now, as it is practically of no importance to us.

We will sum up the resources which are actually at our disposal for making a wire speak. We can act upon the direction of the emission, positive or negative. We can make it long or short, the intensity can be strong or weak, the intervals variable or constant. This is not all, we can mingle the emissions as we can mingle sounds, and disentangle them afterwards, we can act simultaneously at both ends of the line and obtain in the midst of this apparent confusion distinct signals. These signals can be reproduced for the sight, for the hearing or even for the taste; they can be printed in the telegraphic characters or in the ordinary manner, or the apparatus can be of the mechanical or chemical order. We seem bewildered at first among so many wonderful modes of procedure, and we feel that classification is necessary before penetrating such a labyrinth. We shall attempt this task at some future time; now, we must confine ourselves to the subject in hand. When we use all the resources above-mentioned, the number of combinations is very high; we will now consider one of the simplest methods. We will suppose that the duration, interval, and intensity are all constant, and that only the direction varies. With a single positive or negative emission we can make two signals; with a combination of two positive or negative

emissions we can make four, with three emissions eight signals, with four sixteen, and with five thirty-two signals. We will stop at this number which more than includes the number of letters in the ordinary alphabet.

This system has been chosen by M. Baudot, as it presents in practice some remarkable advantages. The uniformity in the duration, interval and intensity of the emission, singularly facilitates and accelerates the transmission, as we shall hereafter show. But still a defect remained, one common to all modes of transmission by hand. The wire is not occupied during the intervals of manipulation, *i.e.*, during the time employed in the preparation of the signal, which preparation necessitates the movement of the hand. A contrivance suggested by M. Rouvier in 1858 and applied by M. Meyer in 1871, consists of employing these lost intervals in the transmission of the signals of the other employés between the two intervals of working of one. It may be compared to a game at skittles, in which the balls are thrown successively by the different players, so that each one, after having thrown a ball, may have time to prepare to send a second one. This principle will hereafter be explained more in detail. These premises being made, we will now give a description of the Baudot apparatus.

Let us consider merely a transmitter at one point corresponding with a receiver at the end of the line (figs. 1 and 2).

Fig. 1 shows at the transmitting station : (1) a key-board with five keys ; (2) a distributor with five contacts ; fig. 2 shows at the receiving station : (1) a distributor like that in fig. 1 ; (2) a group of electro-magnets. The arms bearing the rubbers, F and F^1, of the two distributors are moved by clock-work and turn in synchronism.

The five keys of the key-board are respectively in electric communication with the five metallic contacts of the distributors, and can each oscillate between two stops, one of which, the black, with which they are kept in contact by a spring when at rest, is connected with the negative pole of one battery, and the other, the white, upon which they rest when they are displaced for the purpose of working them, is connected with the positive pole of another battery.

The rubber, F, on the distributor at the transmitting point, is connected with the rubber, F^1, of the distributor of the receiver, by means of the telegraph line. The five metallic contacts of this distributor are respectively in electric communication with five electro-magnets with a polarised armature ; this armature which is magnetised, takes one position under the influence of a positive current and another under the influence of a negative current. In the first case it rests upon its white stop, and in the second, on the black one.

It is easy to understand that if the rubbers of the distributors at the two stations start together from the same point and turn in synchronism, they will pass at the same time to the contacts which are placed symmetrically, and consequently, by means of the line and the distributors, an electric communication will be established in succession between the key 1 of the key-board and the electro-magnet 1 at the other station between the key 2 and the electro-magnet 2, the key 3 and the electro-magnet 3, and so on. During the passing of the rubbers over the contacts of the distributor, each of the five contacts will receive either a positive or negative current, and consequently will place its armature either on its white stop or on its black one, according to whether the key, with which it has been put into communication by means of the line, has been pressed down or left in a state of rest.

We will call the white stops of the armature and the keys, working stops, and the black stops, stops of rest.

Let us now suppose that one or more keys have been pressed down and set working, the others having been left at rest ; we see that after the passage of the rubbers over the contacts of the distributors, the armatures of the electro-magnets at the receiving station will reproduce the combination made by the transmitter, *i.e.*, each armature corresponding to the key pressed down will be displaced, and be set at work, while the others will remain at rest.

(*To be continued.*)

DESIGN FOR ELECTRICAL LABORATORY.—In response to an advertisement for the above design, we have received drawings from nine competitors. The award will be announced in an early number.

MEASUREMENTS WITH A DYNAMO-ELECTRIC MACHINE, No. 2B, AND SIX LARGE HANGING LAMPS ON THE GÜLCHER SYSTEM.

WE have already noticed the Gülcher system of lighting on p. 386 of the last volume. There was neither time nor opportunity at the Paris Exhibition to make more exact experiments, therefore we accepted the kind invitation of Herr Gülcher to try these experiments at his establishment at Biala. The experiments lasted several weeks, and an exhaustive programme was worked out. Some of the measurements were performed by us personally, others by other engineers. The results noted in the experiments made after ours accorded almost exactly with those obtained by us with the machines in question. These machines were of the same dimensions as those exhibited in Paris, but with thinner coils of wire. The experiments were made with the best instruments known to us, and which were procured quite new for the purpose.

The current strength was obtained by means of a Siemens' electro dynanometer, and the tension by means of a Siemens' torsion galvanometer. To measure the resistance, the Siemens universal galvanometer was used, while an Emerson dynamometer showed the result. Particular attention was also bestowed on the photometric measurements. The Bunsen photometer was so constructed that no other light would have any effect upon it. For this purpose the sheet of paper was fastened into a wooden case with a partition at right angles in the middle. Both surfaces could be observed together through a tube placed sideways by means of an inclined mirror. The two ends of the case were closed, serving as screens for the brass tubes. It need not be said that all parts were made dark. The German gas candles and the standard paraffin candles served as units of light. These were not compared directly with the electric light, but with a petroleum lamp, which was then compared with the electric light.

The employment of these lamps for comparison has many advantages. The intensity of a standard candle varies very much with the length of the flame. With the lamp it is possible to render constant the intensity, which with the candle requires a certain length of flame. Naturally the petroleum lamp must have burnt once before being used with the candles or before both are compared singly, so that the intensity is constant. A standard lamp is also advantageous on the ground that with it smaller and therefore more exact measurements can be made. The photometer was constructed in such a way that it could easily be inclined and set at any required angle. The intensity of the light was measured horizontally and also at an angle of 34°. The latter results are of the most practical value, since the most favourable position for hanging is at that angle. We will now give the results obtained :

MEASUREMENT OF THE STRENGTH OF LIGHT IN RELATION TO THE STRENGTH OF CURRENT.

Horizontal measurements. 6 large hanging lamps used. Photometer lamp = 10 candles. Dynamo machine 640 revolutions per minute. Distance c of the electric lamp from the photometer = 226 cm.

No. of measurement.	Distance c in centimeters.	$a - c$ in centimeters.	a in centimeters.	b in centimeters.	Intensity in standard candles $= 10\frac{a^2}{b^2}$	Current strength in ampères.
1	226	144	370	36	1056	14·6
2	226	146	372	34	1270	15·4
3	226	145	371	35	1123	15·0
4	226	145	371	35	1123	15·2
5	226	144	370	36	1056	14·8
6	226	144	370	36	1056	14·6
7	226	145	371	35	1123	14·8
8	226	146	372	34	1270	15·6
9	226	145	371	35	1123	15·2
10	226	145	371	35	1123	14·8
				Mean..	1132·3	15·00

The greatest deviation of the strength of light from the mean value amounts to 12 per cent. of that value.

2. Readings at an angle of 34°. Six large hanging lamps used. Photometer lamp = 10 candles. Dynamo machine 640 revolutions per minute. Distance c of the electric lamp from the photometer = 314 cm.

No. of measurement.	Distance c in centimeters.	$a-c$ in centimeters.	a in centimeters.	b in centimeters.	Intensity in standard candles $=10\frac{a^2}{b^2}$	Current strength in ampères.
1	314	140	454	40	1288	14·8
2	314	142	456	38	1440	15·6
3	314	141	455	39	1361	15·4
4	314	141	455	39	1361	15·2
5	314	141	455	39	1361	15·0
6	314	140	454	40	1288	14·8
7	314	142	456	38	1440	15·4
8	314	141	455	39	1361	15·2
9	314	141	455	39	1361	15·2
10	314	141	456	39	1361	15·0
				Mean ..	1362·2	15·16

The greatest deviation of the strength of light from the mean value amounts to 5·6 per cent. of that value.

The current strength being on an average constant at 15 ampéres, we can deduce the formula

$$\text{L } 34° = 1{\cdot}2 \text{ L } 0°.$$

II.—Measurement of power employed, by means of an Emerson strap dynamometer.

Number of lamps used.	Number of revolutions of dynamo machine per minute.	Number of H.P. expended.	
		Exact.	In round numbers.
None, machine running clear	645	H.P. 0·51	H.P. 0·5
1	640	2·49	2·5
2	640	4·12	4·0
3	640	5·62	5·5
4	640	7·04	7·0
5	640	8·58	8·5
6	630	10·05	10·0

A single lamp burnt with an intensity of 1,250 candles. With 2 lamps the intensity per lamp amounted to about 1,500 candles. With 3, 4 and 5 lamps employed the intensity was constant and amounted to about 1,350 candles. With 6 lamps the intensity sank (but in each case only because the strap slipped and the machine only made 630 revolutions per minute instead of 640) to about 1,200 candles per lamp.

Hence the average power expended amounts to 1·66 horse-power per lamp of an intensity of about 1,350 candles.

The power expended increases at the rate of about 1·5 horse-power for each fresh lamp added, as is shown by the above table.

III.—Resistance of the Gülcher dynamo machine, No. 2.

Resistance.	Before being charged, at 13° R.	After some hours' working, at 25° R.
Total . . .	0·259 ohms.	0·265 ohms.
Of the ring . .	0·133 ,,	0·136 ,,
Of the electro-magnet	0·126 ,,	0·129 ,,

Thus the raising of the temperature of the machine is very slight, and the consequent increase of resistance quite insignificant.

IV.—Tension Measurements.

Difference of Potential	Volts.
At the terminals of the machine . .	60·00
At the ends of the electro-magnets .	10·22
At the brushes	70·22

From these measurements we deduce that :

Total strength of current = 80 ampères.
Electromotive force of the machine = 81 volts.
Average strength of current per lamp = 13 ampères.

Summary of results obtained (amount of work performed). For the total work of the whole circuit we have the formula—

$$\text{H.P} = \frac{[\text{J W} + (\text{v}' - \text{v})]\,\text{J}}{9{\cdot}81 \,.\, 75}$$

in which J represents the total strength of current in ampères, W the total resistance of the machine, and $\text{v}'-\text{v}$ the difference of potential at the terminals of the machine in volts.

According to this formula the results of the measurements are as follows :

Total effect obtained from the whole circuit = 8·82 horse-power.
Effect obtained from the wires of the machine = 2·30 ,,
Total effect in the outer circuit = 7·52 ,,
Power required by the machine alone (see II.) 0·51 ,,

Hence the total expenditure of power including that required by the machine itself = (8·82 + 0·51) = 9·33 HP. Whereas the Emerson dynamometer gave 10·05 horse-power. Thus 0·72 horse-power are absorbed by the Foucault currents passing through the iron of the ring. Thus the result g obtained by this method of arrangement as regards the total effect in the outer circuit is as follows :—

$$g = \frac{7{\cdot}52 \cdot 100}{10{\cdot}05} = 74{\cdot}8 \text{ per cent}$$

Relation between the intensity of light obtained and the amount of power expended :

Total intensity = (6·1362·2) or in round numbers 8170 candles.
Average intensity per lamp in round numbers = 1360 ,,
Intensity per horse-power = $\frac{8170}{10{\cdot}05}$ = 813 ,,

—*Zeitschrift für Angewandte Electricitätslehre*, Vol. iv., No. 4.

NOTES.

ON THE METHODS OF COMPARING THE CO-EFFICIENTS OF INDUCTION.—By M. Brillouin.—The author shows that it is easy to construct two coils whose mutual co-efficient of induction is theoretically calculable with any degree of precision required. By means of the methods of comparison which he has studied the induction co-efficient of coils, peculiar or mutual, may be calculated to $\frac{1}{2000}$.—*Comptes Rendus*.

M. DECHARMES, in a memoir submitted to the Academy of Sciences, shows the possibility of imitating the phenomena of electro-magnetism by means of currents of liquids.

ON THE ELECTRIC TRANSPORTATION OF POWER TO GREAT DISTANCES.—By M. Marcel Deprez.—The experiments which have been made on the transportation of mechanical power by means of electricity have been confined to short distances. In the case of Noiziel, the distance did not exceed 3 kilometres, the two stations being connected by wires of which the resistance was feeble. In the various applications known there has never been more than 6 to 8 horse-power transported to a distance of 5 kilometres, and with machines weighing 500 kilos. Conveyance to great distances has often been declared impossible. It may therefore be interesting to note the experiment which I have just completed. With Gramme machines of the small kind, weighing about 100 kilos, modified on principles which I have pointed out, I have obtained effective work of 37 kilogrammetres, the resistance interposed between the motor and the recipient being 786 ohms, representing a distance of 78·6 kilometres of common telegraphic wire. To put this result in a more prominent light, I place the elements of the experiment in juxtaposition with those of an analogous experiment recently made by M. Fontaine with larger machines.

	Speed.	Effective work.
Fontaine	1,570 rev.	21·5 kilogrammetres
Deprez	2,300 do.	38·0 do.

Work per Revolution.	Yield.
0·8 kilogrammetre.	0·38.
1·0 do.	0·25.

Resistance interposed.
4·65 ohms.
786·00 do.

This transfer of power was effected without the appearance of sparks at the brushes; the machine remaining perfectly cold and without taking any special precautions for the insulation of the conductors. The yield of 0·25 obtained is but the result of a first experiment. I have not yet had time to study the best conditions of speed, of static effort, and of electromotive energy. There is no theoretical reason why a better result should not be obtained, and I am confi-

dent of speedily realising it. Still, I thought it best to make known without loss of time a result of electric transference hitherto considered impracticable.—*Comptes Rendus.*

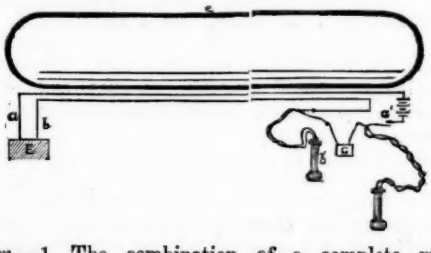
ON THE GENERALITY OF THE ELECTRO CHEMICAL METHOD FOR THE FIGURATION OF EQUIPOTENTIAL LINES.—By M. Ad. Guébhard.—The author has presented to the Academy of Sciences a series of experimental pieces, whence results the possibility of extending to cylindric electrodes, vertical to lines of direction, the equipotential formula established for Nobilis' rings.—*Comptes Rendus.*

ON ELECTRIC ACTIONS IN SIMILAR CONDUCTIVE SYSTEMS.—By M. Marcel Deprez.—It is not always easy, if the actions which are developed under the influence of an agent in a system of given dimensions are known, to foresee *a priori* the actions which will be developed in a system of different dimensions. If the agent in question is heat, the solution of the problem is very complex. If on the contrary it is electricity, the solution may be obtained. If we augment all the dimensions of a conductive system of any form soever according to a given ratio K, without changing the electric flux which traverses the unity of a section of the wire, the resultants of all the elementary static efforts increase as the fourth power of K. If the volume and the form of a conductive system are invariable, a given static effort requires always the same expenditure of effort to be produced. If all the dimensions of a conductive system are increased in the ratio K, one and the same effort F is produced with an expenditure of energy K times smaller.—*Comptes Rendus.*

MORSE AND WHEATSTONE TELEGRAPH PAPERS. — The *City Press* states that the contract to supply Her Majesty's Government and the Post-office with printing papers in endless coils for the Morse and Wheatstone instruments has been secured by Messrs. Waterlow and Sons (Limited). The contract comprises in the aggregate about 700,000 coils of paper, weighing 170 tons, and upwards of 156,000 miles in length.

THE THOMSON RECORDER.—We learn that Mr. Clement Chevallier, electrician and assistant superintendent of the Eastern Telegraph Company at their Aden station, has lately substituted permanent magnets for the large electro-magnets hitherto used for the "field" magnets of the Thomson recorder. The results obtained by him upon the Company's Aden cables have been most satisfactory. The employment of permanent magnets must necessarily reduce considerably the cost of working the recorder, for at Aden we are informed, as many as twenty of Sir W. Thomson's tray batteries were used to excite the "field magnets" of each recorder instrument. These batteries require not only daily attention, but consume per day for each cell about 4 oz of sulphate of copper. To those practically acquainted with the working of the recorder at any cable station the advantage gained by the employment of permanent magnets will be readily understood. We may mention that the large permanent magnets used were specially made by the India-Rubber, Gutta-Percha, and Telegraph Works Company, at their Silvertown Works.

ANTI-INDUCTION CABLE.—Filed in the United States of America Patent Office, July 14th, 1881.



Claim.—1. The combination of a complete metallic circuit of low resistance placed in the interior of the cable among the other conductors, with one of said conductors used as a primary circuit and several of said conductors used as secondary circuits, whereby the effects of induction are overcome, substantially as and for the purpose specified.

2. In a telegraph cable, the combination of separately-insulated conducting wires with a complete metallic circuit of low resistance, which is placed centrally among the said conducting wires, as and for the purpose set forth.

3. A telegraph cable containing several primary wires, in combination with a complete metallic circuit of low resistance placed centrally among the other conductors, whereby tertiary currents are induced, as and for the purpose set forth.

4. The combination of primary line *a*, key *a'*, or its equivalent, one or several secondary lines, *b*, and the low resistance wire, *c*, whereby tertiary currents are induced in said line or lines, *b*, as and for the purpose set forth.

ELECTRICITY AND THE NEW LIGHT.—Mr. Thomas Murby has just added to his "High School Series" a capital text-book on magnetism and electricity for students, from the pen of Dr. Wormell, head master of the Middle-class Schools, Cowper Street. It is a thoroughly complete book on the subject, and one of its chief merits is that it does not assume previous knowledge on the part of the student, whom it leads up gradually. A section is devoted to electric lighting, and lucidly explains the systems. The text is assisted very materially by diagrams.

THE G. P. O. TELEGRAPHS.—The Telegraph Department of the General Post Office is so closely intertwined with the City, and draws such a vast income from within the jurisdiction of the Corporation, that the balance-sheet for the past financial year is of wide interest. That it should only be issued on Wednesday, though it brings its figures down to no later date than the end of March last, seems to indicate that a Circumlocution Office is still extant. However, late though the return is in appearing, the statistics are satisfactory. Receipts from messages and rents of private wires produced £1,592,948; "extra receipts," £21,459; and free services rendered to the State are valued at £19,479; making a total income of £1,633,886. The outlay for maintenance, salaries, and wages amounted to £1,181,324, thus leaving the very satisfactory profit of £440,460. As the amount raised on capital account was £10,655,371, the profits of the twelve months were sufficient to pay the respectable dividend, if the Chancellor of the Exchequer ever did anything in that line, of 4·13 per cent. It would be interesting to know what proportion of this was derived from the City!—*City Press.*

THE COMMISSION OF SEWERS AND ELECTRIC LIGHTING BILLS.—The Acting Remembrancer (Sir T. J. Nelson) said he had to ask the Commission to authorise the signature of five petitions against the various Electric Light Companies' Bills before Parliament. On the previous night, the President of the Board of Trade stated in the House of Commons that the Government intended to bring in a public Bill dealing with these Electric Light Companies' Bills. Probably that Bill would be referred to a Joint Committee of the two Houses, or to a Special Committee of the House of Commons. He thought the Commission should be represented before that Committee, and he therefore suggested that in addition to the petitions which the Finance and Improvement Committee had previously recommended, that the Commission should also sign petitions against the Electric Lighting Bills. This was agreed to, and the petitions were signed accordingly.

ACCIDENT FROM THE ELECTRIC LIGHT.—According to the *Operator*, an accident, which might have resulted in serious consequences, recently occurred in Wanamaker's Grand Depôt, Philadelphia. A girl employed there was dared by another one to touch the electric light wires. The lights had just been turned on. The girl, not realising the danger she ran, touched the wires, the result being a shock which stunned her and kept her away from her duties for some time.

PILE DRIVING BY ELECTRICITY.—At Hatfield Park, the seat of the Marquis of Salisbury, the piles to support a coffer dam across the River Lea have just been successfully driven by the power from a water-wheel situated at a distance, which power was transmitted by two dynamo machines and a couple of wires to the gearing connected

with a pile-driver of ordinary construction erected on a barge floating in the river. The machinery, although rather roughly constructed, worked well, lifting a dolly weighing from four to five hundredweight with ease and regularity.

UNITED STATES PATENT OFFICE.—We extract from the Annual Report of the Commissioner of Patents for the year ending December, 1881, the following interesting particulars :—

SUMMARY OF THE BUSINESS OF THE OFFICE.

Number of applications for patents for inventions.....	24,878
Number of applications for patents for designs	678
Number of applications for reissues of patents	503
Total number of applications relating to patents	26,059
Number of caveats filed	2,406
Number of applications for registration of trade-marks.	611
Number of applications for registration of labels	363
Number of disclaimers filed	14
Number of appeals on the merits	789
Total	4,183
Total number of applications requiring investigation and action	30,242
Number of patents issued, including designs	16,113
Number of patents reissued	471
Number of trade-marks registered	834
Number of labels registered	202
Total number of patents granted and certificates issued	17,620
Number of patents expired during the year	4,638
Number of patents withheld for non-payment of final fee	1,511
Patents issued to citizens of the United States	15,118

Patents issued to citizens of foreign countries, 995, England claiming the greatest number.

COMPARATIVE STATEMENT OF THE BUSINESS OF THE OFFICE FROM 1837 TO 1881 INCLUSIVE.

Year.	Applications.	Caveats filed.	Patents and reissues.	Cash received.	Cash expended.	Surplus.
1837	...	...	435	$29,289 08	$33,506 98	...
1838	...	...	520	42,123 54	37,402 10	$4,721 44
1839	...	...	425	37,260 00	34,543 51	2,716 49
1840	735	228	473	38,056 51	39,020 67	...
1841	847	312	495	40,413 01	52,666 87	...
1842	761	391	517	36,505 68	31,241 48	5,264 20
1843	819	315	510	35,315 81	30,776 96	4,538 85
1844	1,045	380	495	42,509 26	36,244 73	6,264 53
1845	1,246	452	504	51,076 14	39,395 65	11,680 49
1846	1,272	448	638	50,264 16	46,158 71	4,105 45
1847	1,531	553	569	63,111 19	41,878 35	21,232 84
1848	1,628	607	652	67,576 69	58,905 84	8,670 85
1849	1,955	595	1,068	80,752 98	77,716 44	3,036 54
1850	2,193	602	993	86,927 05	80,100 95	6,816 10
1851	2,258	760	872	95,738 61	86,916 93	8,821 68
1852	2,639	996	1,019	112,656 34	95,916 91	16,739 43
1853	2,673	901	961	121,527 45	132,869 83	...
1854	3,328	868	1,844	163,789 84	167,146 32	...
1855	4,435	906	2,012	216,459 35	179,540 33	36,919 02
1856	4,960	1,024	2,506	192,588 02	199,931 02	...
1857	4,771	1,010	2,896	196,132 01	211,582 09	...
1858	5,364	934	3,695	203,716 16	193,193 74	10,522 42
1859	6,225	1,097	4,504	245,942 15	210,278 41	35,663 74
1860	7,653	1,084	4,778	256,352 59	252,820 80	3,531 79
1861	4,643	700	3,329	137,354 44	221,491 91	...
1862	5,038	824	3,532	215,754 99	182,810 39	32,944 60
1863	6,014	787	4,184	195,593 29	189,414 14	6,179 15
1864	6,932	1,063	5,025	240,919 98	229,868 00	11,051 98
1865	10,664	1,937	6,616	348,791 84	274,199 34	74,592 50
1866	15,269	2,723	9,458	495,665 38	361,724 28	133,941 10
1867	21,276	3,597	13,026	646,581 92	639,263 32	7,318 60
1868	20,420	3,705	13,410	681,565 86	628,679 77	52,886 09
1869	19,271	3,624	13,997	693,145 81	486,430 78	206,715 03
1870	19,171	3,273	13,333	669,456 76	557,149 19	112,307 57
1871	19,472	3,366	13,056	678,716 46	560,595 08	118,121 38
1872	18,246	3,090	13,613	699,726 39	665,591 36	34,135 03
1873	20,414	3,248	12,864	703,191 77	691,178 98	12,012 79
1874	21,602	3,181	13,599	738,278 17	679,288 41	58,989 76
1875	21,638	3,094	14,837	743,453 36	721,657 71	21,795 65
1876	21,425	2,697	15,595	757,987 65	652,542 60	105,445 05
1877	20,308	2,809	14,187	732,342 85	613,152 62	119,190 23
1878	20,260	2,755	13,444	725,375 55	593,082 89	132,292 66
1879	20,059	2,620	13,213	703,931 47	529,638 97	174,292 50
1880	23,012	2,490	13,947	749,685 32	538,865 17	210,820 15
1881	26,059	2,406	16,584	853,665 89	605,173 28	248,492 61

The receipts of the Office during the past year exceed those of any previous year by nearly 100,000 dols., or more than 14 per cent.; and the excess of receipts over expenditures (248,492·61 dols.) has been correspondingly greater. In no former year have there been so many applications for patents, or so many patents granted.

DIGESTS.

The digest of American patents, for which a provisional appropriation was made by Congress at its last session, has been in progress since the beginning of August last. It is proposed to furnish to the Office and the public at large classified briefs of all American patents. Thus the examiner or the inventor will not only have at hand an adequate digest of each case under its proper classification, but he can dispense with a search that is often very laborious for references in the broader classes under which the special invention is comprised. It is hardly possible to overestimate the benefit that will inure to the Office and to inventors from the prosecution of this work.

AMENDMENTS OF THE LAW.

Section 4886 of the Revised Statutes provides, as one of the conditions necessary to the obtaining of a patent, that the invention shall not have been "in public use or on sale for more than two years prior to the application;" and Section 4920, relating to the grounds of defence in an action for the infringement of a patent, provides that the defendant may plead "that it had been in public use or on sale for more than two years before his application for a patent, or had been abandoned to the public." The theory of our patent system is that it is the duty of the Commissioner to determine in advance the right of an applicant to a patent. The plea of public use, if sustained, operates to defeat a patent. Notwithstanding the theory above stated, and notwithstanding the fact that public use is made a bar to the grant and to the validity of a patent if granted, the Commissioner has no means of ascertaining the fact except in cases of notorious public use. It frequently happens that the fact is alleged by parties interested in the defeat of an application, and affidavits to that effect are filed, coupled with a protest against the granting of the patent. As these protests are prompted by self-interest, and as the only practical means of bringing the matter to the attention of the Commissioner is by *ex parte* affidavits procured by interested parties, and as the affiants cannot be compelled to appear for cross-examination by any process of law, this kind of evidence is of a very unsatisfactory character, and applicants may well object, as they do, to having their rights determined upon such questionable evidence.

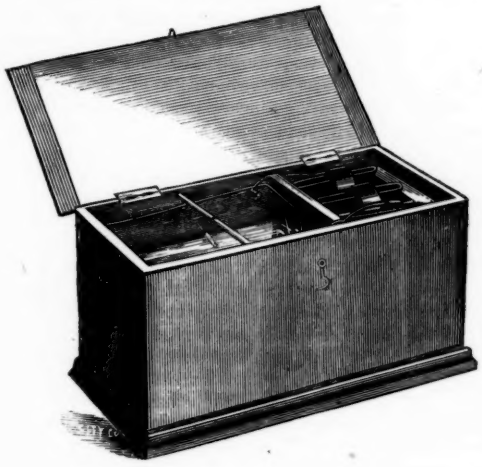
Serious question has arisen as to the proper construction to be put upon that part of Section 4887 which provides that—

> Every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent; or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than seventeen years.

It is contended by many lawyers practising before this Office that the limitation here indicated applies only to inventions which were patented abroad before the application was filed for an American patent, while others of equal authority hold that the priority contemplated by the provision is priority of grant, and this corresponds with the later rulings of the Office. As a matter of fact, it is often impossible to ascertain whether a given invention has been patented in a foreign country or not. The case may be pending in several countries at once, and after the American patent has been granted it may be discovered that the same invention was patented abroad on the day before it was issued here. If it is the desire of Congress to limit in any case the duration of the American patent by that of a previous foreign patent for the same invention, it is hoped that the statute will be so amended as to leave no room for doubt. But when it is considered that our patent system is intended to "promote the progress of the useful arts," and when it is remembered what our liberal patent system has already done for the accomplishment of this end, it may well be doubted whether all proper inducements should not be offered the foreign inventor to patent his invention in this country. There would seem to be no valid reason why

an invention that has been patented elsewhere should not, if found new and useful, be protected in this country for the same number of years as any other invention.

Electro-Plating Apparatus.—Mr. J. E. Chaster, of Manchester, has designed and patented a compact form of apparatus for nickel and silver plating, an illustration of which is shown. The arrangement was devised for the many and varied workers in metal who desire to put a superior finish on their work, and also for jewellers, &c. There are many small articles which appear too trifling to send to a professional plater, and to those dealing or working in such trifles this apparatus would be of great value. It would also be of good service in technical colleges for class demonstration, and is particularly adapted for the use of amateurs in the fascinating occupation of electro-plating. The construction of the apparatus forms its chief merit, bath



and battery being in the same mahogany case. It is said that the E. M. F. of the battery is not quite 4 volts, and the plates having great surface, a considerable quantity of current is obtained. No acids are used, the zincs do not require amalgamation, and Mr. Chaster claims for his battery great constancy. In many cases nickel plating is done with too much E. M. F., the result being that the nickel is very easily chipped off. The following firms, amongst others, are using this apparatus:—Messrs. Dale & Co., Little Britain, Messrs. Orme & Co., Barbican, Mr. Paterson, Little Britain, and Mr. Mayfield, Queen Victoria Street. At the Crystal Palace Exhibition of Electricity it may be seen on the stalls of Messrs. Dale and Orme, from whom all particulars can be obtained.

The Central and South American Telegraph Company's Cables.—We have received information that the sections of this Company's cables from Callao to Payta in Peru, and from Payta to Santa Elena in Ecuador, have been successfully laid by the India-Rubber and Gutta Percha Company's ss. *Dacia*.

Flat *v.* Cylindrical Rings for Dynamo Machines.—In reference to the controversy going on in this matter between Herren Schuckert and Fein, and in answer to a letter of the latter which we gave in our issue of the 28th January, Herr Schuckert says in writing to our contemporary, the *Zeitschrift für Angewandte Elektricitätslehre*, "The cylindrical form is really less advantageous, as the iron of the ring attains its magnetic saturation point earlier. The thicker diameter of my flat ring has, above all, the advantage that the change of polarity is more easily effected, and the remanent magnetism need not first be forcibly discharged. This is not the case with the small rings, in which indeed much work is lost through the remanent magnetism."

The United Telephone Company *v.* Theiler & Sons.—We learn that the respondents in this action have submitted to an injunction.

New Electric Accumulators.—It may interest those who have been looking forward to a practical application of electric lighting to private houses and to a possibly general use of the enormous forces which, by the aid of electricity, may be placed under ready command, to know that great improvements have recently been made in electrical storage or accumulating batteries. It is stated that these improved batteries are of five times the durability and possess 2¼ times the storage capacity of those known as the Faure accumulators, and that they are of such a practical construction that they can be readily renovated when necessary without waste of material, while their first cost is less than that of the Faure. Each cell, of about 43-100 of a cubic foot in size, and consisting of about 60lb. of metallic materials, is capable of containing 400 ampères, and of delivering during eight hours a current of 50. Each cell, in fact, represents over one horse-power of energy for one hour. Public demonstration will be made very shortly, and it is stated that probably within a few weeks, at the Crystal Palace Electrical Exhibition, 200 incandescent lamps will be shown running upon one set of 35 large cells of this new construction.—*Times*.

A notice somewhat similar to the above appeared in the *Standard*, and Prof. W. E. Ayrton writes to the Editor as follows:—

Sir,—In the notice of the Crystal Palace Electrical Exhibition, contained in your issue of this day, there is an article stating that "the New Accumulator is smaller than the Faure Accumulator, and each cell containing 400 ampères of current can deliver 50 ampères per hour for eight hours; whilst the Faure battery, we believe, could not deliver more than 17 ampères per hour."

The number 17 is obviously taken from a number mentioned by me in my communication to the Physical Society on Saturday last, when I was referring to the average current of a Faure's cell during a discharge lasting for several days. I therefore write to correct the error into which your correspondent has fallen in saying that a Faure's cell cannot deliver more than 17 ampères per hour, and his erroneous conclusion that therefore the new secondary cell has greater storing power than the Faure; for the experiments of Prof. Perry and myself show that one of the later forms of M. Faure's cells will give up over 1,440,000 foot-pounds of work; consequently, if it were discharged in eight hours, the discharge would be almost identically the same as that supposed to be produced by the new battery.

Reference has been also made by some critics to the great lasting power of this new accumulator compared with M. Faure's. As, however, the supposed improved form is not yet before the public, while the latter has been in constant use for many months, it is surely somewhat premature to compare the relative durability of the two cells.

I am, Sir, your obedient servant,

W. E. AYRTON.

The City and Guilds of London Technical College,
February 27th.

In the daily press of Wednesday last appeared in full the prospectus of the Faure Electric Accumulator Company, with Professor Ayrton and M. Faure as consulting electrical engineers. The above letter appearing on the same day needs no criticism. We think that some parts of the prospectus are open to comment, and for this purpose we will quote certain passages.

By means of Faure's accumulators electric energy can be stored and retained, to be redistributed as required for the production of light and motive power. The accumulator, indeed, bears the same relation to electric energy as the cistern to water, and the gasometer to gas. The light thus obtained is perfectly steady, and without glare, and its capability of subdivision and storage has now been fully established. For successful and economical application to the lighting of mines, houses, and railway trains, Faure's accumulator offers the exceptional advantage that, in the event of temporary accident to or stoppage of the electric motors, there is no danger of any extinction of the light.

One of the sources from which it is confidently anticipated that this Company will derive a considerable revenue, is the lighting of railway carriages. To light them economically as well as effectually by electricity, accumulators are absolutely necessary, as without accumulators the light would vary in intensity in proportion to the speed, and would be extinguished on the stoppage of the train. A brighter light can be obtained by means of Faure's accumulators than that at present found in railway carriages, and at a cost, including wear and tear and renewals of incandescent lamps, &c., considerably less. The light thus obtained is indeed vastly superior, as may be seen by an inspection of the Pulman Car Train, which has been running on the Brighton Line during the last three months, lighted by electricity supplied by Faure's Accumulators.

According to the published accounts of the Tramway Companies, it may be deduced that the cost of working tramcars by electricity, in conjunction with Faure's accumulators, would show a large margin of saving over the present system. It is anticipated that the profits from this source alone will be considerable.

The motive power may further be at once equally advantageously

employed in the working of fire engines, hoists, cranes, sewing machines, lathes, &c.

In the opinion of men of science, Faure's invention marks a new departure in the practical and economic application of electricity to industrial and domestic purposes, and will necessarily command general adoption.

Sir William Thomson thus expressed himself about it in a letter to the *Times*:—

"The subject is one in which I feel intensely interested, seeing in it a realisation of the most ardently and unceasingly felt scientific aspiration of my life."

To an inquiry addressed to him subsequent to the opening of the Paris Electrical Exhibition, in the following terms:—

"Since the Faure battery has been known and described, has there, to your knowledge, been any other battery discovered which in any way approaches, or can be held to be able to compete with it?"

Sir William Thomson replied:—

"No. I have heard of several other secondary batteries, but none of which approaches to the practical value of Faure's."

It is needless to say that the commercial field for an invention of such value is a wide one. So convinced, indeed, are the vendors that the shares of this Company will pay dividends at a high rate, that they agree to take four-fifths of their nominal purchase-money in deferred shares.

It will be noticed that in this prospectus there is nothing new brought forward in respect to Faure's accumulators. We were under the impression that men of science were pretty well convinced that these accumulators had not in any way acted up to what has been claimed for them, and that the results had been disappointing enough to almost constitute a failure. The opinion of Sir William Thomson as quoted, is that expressed by him about the middle of 1881, and it has been said for some time past that Sir William had privately admitted being mistaken as to their efficacy and practicability. Unless some important improvements have recently been made by M. Faure himself, or others on his behalf, we cannot but think that the statements contained in the Company's prospectus are hardly justified. We fear that many of the uses of the Faure accumulator, so confidently set forth by the Company, must be put aside at any rate for the present. Tramway driving for instance, was tried in Paris last year, 160 Faure cells being employed, weighing 1¼ tons, and costing £800, to drive a car at the rate of six miles an hour, and containing forty persons, this being only experimental. We cannot imagine such an application to fire engines as constituting an improvement over present arrangements. Wherever a dynamo machine can be employed constantly, we cannot see the economy produced by the introduction of a supplementary apparatus in the form of an accumulator.

It would certainly be less costly to light a railway train by the employment of a dynamo machine placed on some part of the locomotive, and worked by a small engine supplied by steam from the locomotive boiler. It might be urged that the machine would be liable to break down, but it is also equally possible that such might be the case with a battery of Faure, or other accumulators.

BERLY'S ELECTRICAL DIRECTORY.—We hear that M. Berly's Electrical Directory will be published next week.

CORRESPONDENCE.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number.

ELECTRIC RAILWAY SIGNALS.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—As was stated at the meeting of Telegraph Engineers last evening (February 23rd), during the discussion on Messrs. Siemens' "System of Gong Signalling on Railways," very few, if any, of our English railways at present use any real block system of outdoor signals. May I therefore be allowed to call the attention of yourself and readers to the system now being shown at the Crystal Palace, Stand No. 131, Eastern Gallery, by the Electric Railway Signal Company of Mansfield, King's patent, which is essentially an outdoor block system? As there shown, it is arranged as an automatic system; but it is equally capable of being worked by signalmen, in which case by the movement of keys, similar to those at present in use for working the indoor block, the outdoor signals would be actuated.

I shall be very glad to give fuller information to any one who will call at the Stand any afternoon after 2·30 p.m.

I remain,

Your obedient servant,

THOS. KIRKLAND, JUN.,

Engineer to the Electric Railway Signal Company.

32, Palace Road, Upper Norwood, S.E.

ELECTRICAL HUMBUGS.

To the Editor of THE ELECTRICAL REVIEW.

DEAR SIR,—In your last number I noticed an extract from the "Young Scientist," in which the application of magnetism for therapeutical purposes is classed among "*electrical humbugs*." I further noticed in the *Daily News* report of Professor S. Thompson's lecture at the Crystal Palace, on the 22nd inst., on electric currents, the following remarks:—"The magnetic, thermal, and physiological properties of the electric current were illustrated experimentally, the lecturer remarking with much emphasis that the mistake of confounding physiological with medical or remedial effects led to the gross impositions of the quacks and rogues who deal in so-called magnetic appliances, and disgrace alike the sciences of electricity and of medicine, while knowing nothing of either."

As the originator of these magnetic appliances in the year 1865, and having had extensive experience in their use for nearly twenty years, I feel in a position to express an opinion as to the true remedial value of magnetism. When the appliances are properly constructed and applied, and suitable cases are selected, magnetism, like other electrical qualities, will be found to have its special sphere of usefulness in a given class of ailments. The therapeutical value of all electrical qualities is based on their physiological actions: hence we have in electro-medical practice three orthodox electrical qualities, viz., Galvanism, Faradism, or induced electricity, and Franklinism, or static electricity—the first exerting a special action on nerve tissue, the second on muscular tissue, and the third acts similarly, though more violently, than the second. Yet another electrical quality may be added, viz., magnetism, which though not at present orthodox, is none the less valuable, its special function consisting in an action upon the *circulating fluids* of the body, and from the facility with which the lines of magnetic force may be caused to pass through glandular structures, congested and debilitated conditions of such organs, viz., the lungs, liver, kidneys, bowels, &c., prove just the cases in which magnetism proves most serviceable.

As facts are worth more than volumes of theory, I shall be very pleased to give every opportunity to physicians and others feeling an interest in cases magnetically treated to watch cases of their own selection; for it will need but little experience to prove indisputably that magnetism as a curative agent is not a humbug, though some of its vendors may be, or even their appliances.

I am, Sir,

Your obedient servant,

P. W. SEYMOUR,

Electrician to Guy's Hospital.

THE CONDUCTION OF ELECTRICITY ALONG SOLID AND HOLLOW CONDUCTORS.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—A few of the clerks in the Telegraph Office here have been pursuing a somewhat desultory study of electrical science, and amongst other questions has arisen one as to whether a current passing through a conductor does so over the surface of the said conductor, or both over the surface and through the substance of it? I have maintained the latter theory alone in opposition to all the others, and although I can see in my own mind how I may be right, I am unable to convey my views to them in a thoroughly satisfactory manner. They bring up the self-repellent nature of electricity (of whatever kind it may be) in forcing a charge always to the surface of a conductor to prove their position. But while I admit the argument in

reference to a static charge upon an insulated conductor, I hold that when that charge is neutralised, by being placed in connection with the earth by means of any conducting substance, whether the charge escapes to earth or whether an opposite charge is attracted from the earth to neutralise it, the current *passing* through the connecting conductor does so not only over the surface but through every particle of that earth connection. I have read somewhere that a hollow wire offers greater resistance to a current than a solid wire of the same dimensions, but as I am not competent to *prove* that, my opponents will not accept the statement. Of course you will see the difficulty is hardly worth while troubling you about; but if you would give us your opinion in the briefest manner, without any reasoning whatever, we should be glad to accept your decision as final. The discussion has been very keen on both sides, but I am sorry to find myself in a minority of one. As I subscribe to the *Journal*, an answer there, or by any other channel, will be gratefully received by

Yours very respectfully,
"KILDONAN."

[Our correspondent is perfectly right in his conclusion that electricity when in motion travels through the *mass* of the conductor, and the proof of this is that: The electrical resistance of a wire varies inversely as the sectional area of the wire, and not as its circumference. If the conduction were over the surface only, a wire $\frac{1}{10}$th of an inch in diameter should have *twice* the resistance of one $\frac{2}{10}$ths of an inch in diameter, since the circumference, or the surface of the wire in the one case, is *one half* what it is in the other. As a matter of fact, however, the resistance of the smaller wire will be *four* times that of the larger wire, because when the circumference of a wire is *doubled* its sectional area is *quadrupled*. The electrical resistance of a tube is more than that of a solid rod of the same diameter and length, inversely in the proportion of the mass of metal which each contains. Thus, if we had a tube one yard long and of a diameter of $\frac{1}{10}$th of an inch, and also a solid wire one yard long and of a diameter of $\frac{1}{10}$th of an inch, and we found that the weight of the solid wire was twice that of the tube, then the electrical resistance of the latter would be found to be exactly twice that of the wire.—ED. ELEC. REV.]

A CHEAP FORM OF VOLTAIC BATTERY.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—With reference to the article in this week's issue on "A Cheap Form of Voltaic Battery," the latter portion of which states, "Having possessed himself of this battery, a man may light his library on a small scale, or drive his wife's sewing machine," would you kindly inform me of a cheap form of lamp for the former, and also how I could cheaply make or purchase a necessary arrangement to produce rotary motion to enable one to work the latter and similar things by electricity? I may mention that the sewing machine I wish to drive is a full-sized "Wheeler & Wilson treadle machine."

I am, Sir,
Your obedient servant,
AMATEUR.

[Perhaps Mr. Bennett or some of our subscribers may furnish our correspondent with the information he asks for. With reference to the electro-motor, the article published in our issue for June 15th, 1881, may prove of service. Swan lamps (manufactured by the Swan Electric Light Company, Newcastle) would probably answer the purpose required.—ED. ELEC. REV.]

SIR W. THOMSON'S EXTRAORDINARY EVIDENCE.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—Sir William Thomson, when examined at Edinburgh by the Lord Advocate, made the following replies as to the point whether the Bell Receiving Telephone described and exhibited by him at Glasgow:—

"Was there anything to suggest to your mind that the implement would be got to speak if you fastened that tongue down?"—"No."

"In the state of your knowledge at that time, and from what you had heard, was it your impression that it ought to be free at one point?"—"Yes."

"Was it, in your knowledge, known that the magnet could set up sounds in the steel plate fastened all round such vibrations as to produce vocal sounds?"—"No."

"Did it not occur to you to fasten down the metal disc?"—"No."

Against this Mr. Conrad Cooke swore that Sir W. Thomson had distinctly told him that the disc in action was held tight down, other persons being present. To this the Lord Advocate replied that Mr. Conrad Cooke must be mistaken, adding: "It is quite plain that Sir W. Thomson could not have said it, because he had not the knowledge to say it."

Now in the official report, signed by Sir W. Thomson and other judges of the Centennial Exhibition, there occurs the following passage:—

"A thin circular iron disc, *held pressed against the end of the tube* by the electro-magnetic attraction and *free to vibrate through a very small space without touching the central pole*, constitutes the sounder by which the electric effect is reconverted into sounds. With my ear pressed against this disc, I heard it speak distinctly several sentences. I need hardly say I was astonished and delighted."

How, I would ask, is it that the distinguished electrician, who can describe so clearly the action of the instrument when acting as judge in America, can six weeks later, on his return to his own country, have "no knowledge" of the actions he had thus witnessed and described? Or, if he had no knowledge, how is it that there appear to be at least two witnesses who remember something being said at Glasgow by Sir William Thomson, which Sir William Thomson himself now says he did not say, and did not even know?

IGNORAMUS.

THE TELEPHONE CASE.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—I am much averse to a controversy in the press with any one on any subject. I hope, however, I may be pardoned for making a few remarks upon the letter of 18th inst., addressed to you by Count du Moncel, which was published in your Review on 25th inst. Count du Moncel's scientific knowledge, and his extensive and deep researches, would deter me from calling in question any opinion on such subjects expressed by him. On the contrary, for years past I have accepted his opinions as established facts, and I may say they have been to me a guide and instructor, and when I made the quotation from his work "Le Téléphone," I had full and unbounded faith in his very concise and emphatic denial of Bell's assertion—that "undulatory currents had never been employed before he had." That denial was in these words: "Ceci n'est pas exact, car M. Elisha Gray en avait déjà reconnu l'importance pour les transmissions des sons combinés." This denial by Count du Moncel was accepted by me as conclusive, the more so as Count du Moncel stated an *antecedent fact*, that Gray *had used undulatory currents*. If any further evidence had been necessary to confirm my belief in the correctness of Count du Moncel's words quoted, I found it in Gray's patents of 1874 and 1875.

My quotation was taken from the first French edition of Count du Moncel's "Le Téléphone," and I was not aware of any other edition.

Count du Moncel, in his letter to you, states that "when he published his first edition in October, 1878, he had had no other information than Gray's patents, and various pamphlets published in America by the same inventor." It seems then that Gray's patents must have furnished evidence sufficient to authorise Count du Moncel to contradict in so emphatic a manner Mr. Bell.

In his letter Count du Moncel says he had changed his opinion on this matter, upon evidence subsequently brought to his notice. No one can doubt for a moment that this last evidence was entirely satisfactory to Count du Moncel, and it seems he lost no time in making the *amende honorable* to Mr. Bell at his request, as becomes a true and noble man, as he is.

I will now make a few remarks on that part of Count du Moncel's letter which relates to Mr. M'Donough's patent of April 10th, 1876. "It seems to me," writes Count du Moncel, "that in the eyes of every impartial man, the invention belongs to the person who has been the *first* to make it known to an authorised patent administration."

It is true that Bell applied for a patent for "*Improvement in Telegraphy*" to the United States Patent Office on February 14th, 1876, nearly two months before M'Donough

applied for his patent for "*Telephones.*" In Bell's patent, no mention is made of the transmission of articulate sounds, although he used an undulatory current, and he described the means he used to produce that current. If an instrument was ever made, or can be made under that patent—which will transmit articulate words—then Bell anticipated M'Donough.

What did Sir William Thomson testify on oath about the instrument shown to him by Bell at the Universal Exhibition at Philadelphia, in July, 1876?

He said, "My attention was called to some devices of Bell for reproducing sounds," and "Bell explained that by an arrangement of a number of such instruments he would be able to make a *speaking* instrument." Do not those words of Bell clearly mean that a speaking instrument had not yet been made? And, further, Sir William said, "The instrument was capable of producing a fixed note, but not capable of transmitting articulate speech." After this: "Bell showed us something which he (Bell) said he could hardly call an invention, but which might ultimately become an invention." "Bell then said he would show us something which would speak, and after some troublesome adjustment it was made to speak. I heard the vowel 'o,' and '*to be or not to be.*'" "He stuck to monosyllables," and this, after troublesome adjustment and many orders to his assistants. "Bell gave me instruments. I tried them, and worked a good deal with them, but all with no effect, but I never got it to speak. I dropped my experiments with the instrument at Glasgow as a failure."

It is evident, then, that some instrument used by Bell at that time did repeat monosyllables; but it may justly be asked, Was that instrument made exactly in conformity with the specifications of Bell's patent of February 14th, 1876, for there is no evidence of that fact?

Sir William Thomson proceeded to say that Bell subsequently introduced some improvements, viz., "the substituting for the loose tongue an iron or steel plate, and attaching the plate all around its edges to a solid body," and "the substitution of the permanent magnet for the electro-magnet." Here, then, we have the first speaking instrument made by Bell. The first evidence of any authorised patent administration of those improvements is the patent of Bell, obtained in England December 9th, 1876, and in the United States January 15th, 1877.

Does not the evidence of an authorised patent administration (evidence conclusive "in the eyes of every impartial man") prove that M'Donough perfected a speaking telephone on April 10th, 1876, and that Bell arrived at the same result on December 9th, 1876. If, however, an instrument which will speak a few monosyllables be an instrument capable of transmitting articulate sounds, Herr Reiss's telephone of 1861 is the first known.

I respectfully ask whether M'Donough described in his patent an instrument which will transmit articulate speech? The answer cannot but be "Yes," and we have the evidence of an authorised patent administration, viz., the United States Patent Office, that a full description and drawings of his receiving instrument and of his transmitting instrument was filed on April 10th, 1876. Does not M'Donough's patent describe also a microphone? Certainly it does.

I think that the patent issued to M'Donough by the United States Patent Office is conclusive evidence that on April 10th, 1876, M'Donough had invented a good speaking telephone and a microphone.

I conclude this long letter with an urgent appeal to all persons to produce the evidence of an authorised patent administration of any speaking telephone or microphone anterior to the date of M'Donough's application for patent to the United States Patent Office. *Palmam qui meruit ferat.*

Yours truly,

London, *Feb. 28th*, 1882. W. C. BARNEY.

"C." writes to us as follows:—"My opinion is that the telephone as we have it in the present form has passed through so many stages of development and through so *many hands*, that the *principle* of it cannot rightly be claimed by Bell, although he or any other inventor may patent a method of obtaining speech transmitted by electricity in which the *principle*—viz., undulatory currents—is there, though obtained in a modified or different form from another inventor, and yet hold water."

RAILWAY SIGNALLING.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—I notice a patent in your issue of February 25th, 1882, No. 2,711, on page 147, which is pretty nearly identical with mine, and to prove this, I beg to inclose you a pamphlet upon the subject.

Yours truly,

DAVID SALOMONS.

Broomhill, Tunbridge Wells, *Feb. 25th*, 1882.

[The idea of signalling between a railway train and the stations between which the same is running, is very old. All the new inventions brought out on the subject differ only in detail, but we have not yet seen any system of the kind which is of real practical value.—ED. ELEC. REV.]

H. L. TH. O. TOOLE.—We would recommend you to obtain "The Speaking Telephone, Talking Phonograph, and other Novelties," by G. P. Prescott, which may be obtained from Messrs. Spon, 18, Charing Cross, London, S.W. There is no work in which any information is given about the construction and testing of telephone lines. "A Handbook of Practical Telegraphy," by R. S. Culley, and "Telegraphy," by Preece and Sivewright, both published by Messrs. Longmans, Paternoster Row, London, E.C., will give you the most information on the construction and testing of telegraph lines generally.—ED. ELEC. REV.

PROCEEDINGS OF SOCIETIES.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

AN ordinary general meeting of this Society was held on Thursday, February 23rd. Lieut.-Col. WEBBER, R.E., President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, a paper was read by Mr. R. VON FISCHER TREUENFELD, "On Siemens' Railway Gong Alarm." The system of electric gong alarms was first introduced as early as the year 1847, and has since been extensively used on the Continent, but not in England. The reason of this is that the cases where the alarms are required do not occur in this country, consequently they would be of little use. The object of the gong alarms is to give warning, at various points on a long line running through a flat country, of the approach of a train. On the Continent, lines run a long distance between two stations over flat stretches of country where level crossings are required; at each of these level crossings an electric alarm gong is stationed close to the hut of the level crossing gatekeeper, who would be summoned by the gong being sounded, and would then close the gates. The gongs are sounded the moment the train leaves the station to enter on the section of line along which are the level crossings to be protected. Mr. TREUENFELD said that the gong system would prove useful in the colonies, where the railway tracks were similar in character to those on the Continent, but he thought that the reason why it had not been adopted up to the present was because the colonies usually followed the practice of the mother country. The gong system was not for block working, but could be made accessory to the latter.

The gong alarm was originally set off by means of a hammer, which was released by an electro-magnet; this hammer in falling struck a detent and disengaged the mechanism which worked the hammers. This arrangement was not, however, satisfactory, as an accidental current might set it in action, or even an accidental shake. In the present system several strong reversals sent by a magneto machine are required to release the clockwork. The reversals actuate a polarised armature which is attached to an anchor escapement, the latter engaging into a segmental rack; as soon as all the teeth of the latter have passed the escapement the gong sounds.

The gongs are either placed on iron columns or are mounted on the roof of the gatekeeper's hut. They contain one, two, or three gong-bells.

At the signalling stations Morse telegraph instruments are provided, the connections being such that the same line wire will do either for working the gongs or working the Morse instrument.

The whole arrangement is shown by Fig. 1. The batteries, B_1, B_2, B_3, keep a continuous current flowing to line. When station (2) wishes to signal to station (1) and sound the gongs along the line, he depresses key, K_2, and turns the handle of the magneto machine, D_2, the gongs, C_1, C_2, are thus sounded, and also the bell, b_1. If station (2) wishes to communicate with station (1) by Morse, he depresses the pedal, P_2, by means of his foot, and then sends Morse signals by means of key, K_2, and station (1), on hearing the call, presses down his foot pedal, P_1, thus bringing his key, K_1, and recorder, R_1, in circuit, and then receives the despatch. The keys, K_1, K_2, and K_3, have no retractile springs, but normally rest on their front contacts. The batteries, B_1, B_2, B_3, which normally keep a current on the line, enable the gatemen at the level crossings to communicate with the signalling stations in case of a train breaking down. For this purpose

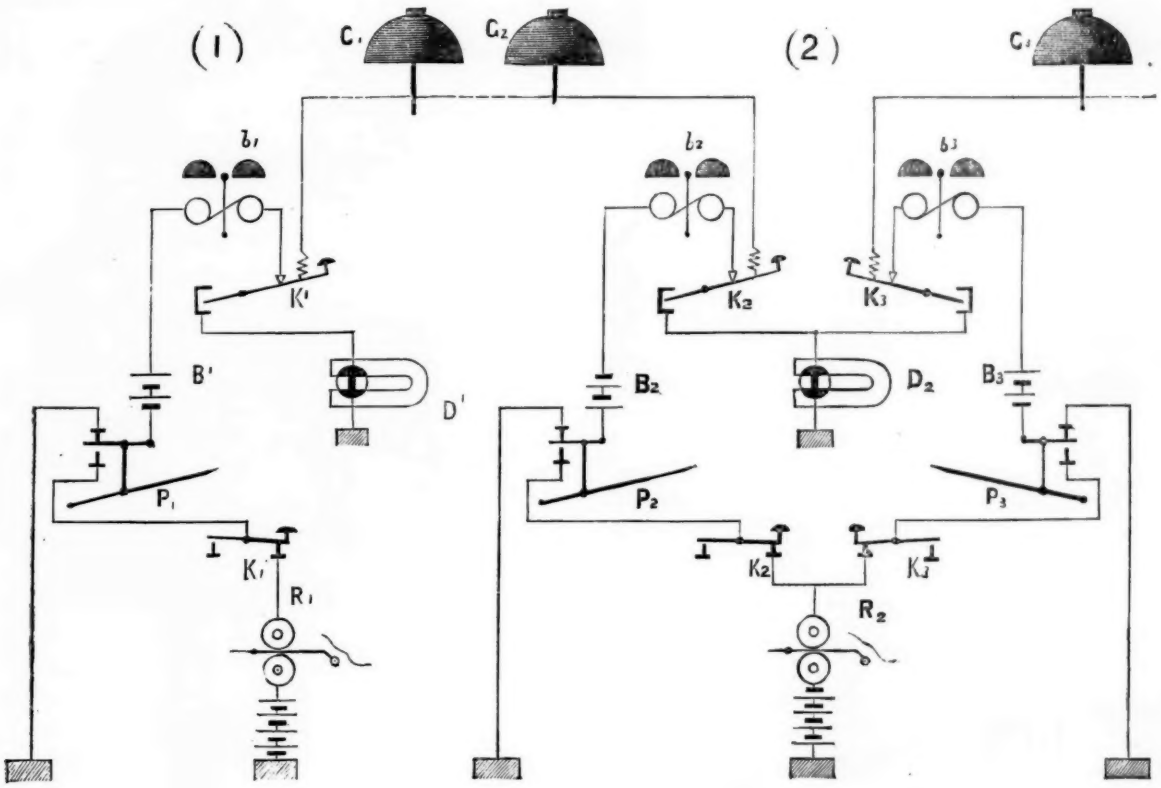


FIG. 1.

a number of keys are provided at each hut; any one of these keys can be inserted in a keyhole in the iron column on which the gong is fixed. When turned the key sets in action a contact wheel, which sends makes and breaks at regular intervals, the combination of these makes and breaks depending upon the key which is used to send the signal. These signals are continued to be sent until attention is called at the signalling stations, when the latter can send currents from his magneto machine, D_1, and by thus sounding the gong can indicate that his attention has been obtained.

The Morse instruments are so arranged that when placed in their position on their tables they became connected up to their batteries, line wire, &c., by means of spring contacts. This is a very convenient arrangement, as if an instrument becomes faulty a new one can be put in its place without skilled labour.

Figs. 3, 4 and 2 show the magneto machine, the gong, and the gatekeeper's hut respectively.

Mr. TREUENFELD, in conclusion, stated that a French committee in 1879 examined 218 different signalling systems and recommended Messrs. Siemens' very strongly. It was stated that the system had never caused an accident, whilst, on the other hand, it had many times prevented them. The gongs were made compulsory in cases where there were six trains in twenty-four hours.

In the discussion which followed the reading of the paper

Mr. SPAGNOLETTI inquired what would be the expense of the gong apparatus; he considered that it would prove a rather serious item. He thought that the clockwork was an objection in the gong, as it might run down through forgetfulness on the part of the gatekeeper. The absence of a visual signal he also thought a mistake; visual signals are, as a rule, better than aural ones. With regard to block signalling generally, he insisted very strongly on the necessity of having a uniform code of signals for all railways, as this want of uniformity was very liable to cause accidents at junctions of one railway system with another. The principal signal ought to be as short as possible, and the others should be in proportion to their importance. He mentioned that in 1880 there were 541 million passengers carried by railway in England, 46 million in Scotland, and 17 million in Ireland, whilst the number of fatal accidents that had occurred in a similar period (1879) was but one in every 3,517,000 persons carried. He thought that the electrical locking of the outdoor signals from one station to another was of great importance, and it would be largely adopted as accessory to the general "slotting system."

Mr. PREECE said that twenty years ago he had read a paper before the Institution of Civil Engineers, in which he strongly advocated the application of electricity to railway signalling purposes; he stated that at that date, with one exception, all the railway managers opposed his recommendation. At an early date Mr. C. V. Walker, of the South Eastern Railway, had applied a system of bell signalling for conducting the traffic on that railway. At the present time the Board of Trade insist upon visual as well as aural signals being given. He thought that the Siemens gong system could not be usefully applied anywhere in England. He strongly agreed with Mr. Spagnoletti in

advocating the adoption of a uniform code of signals, though there would be considerable difficulty in obtaining it, as at present the codes adopted by the various companies were very diverse, whilst each considered their own the best. With regard to railway accidents he would state that 50 only out of every 17,000 accidents were those caused by railways. He strongly urged the employment of the single needle as the instrument *par excellence* for railway purposes,

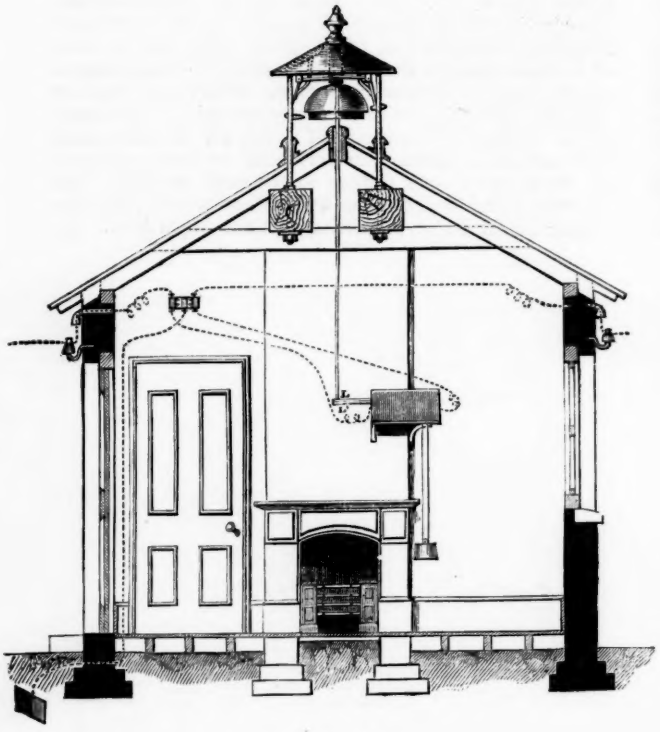


FIG. 2.

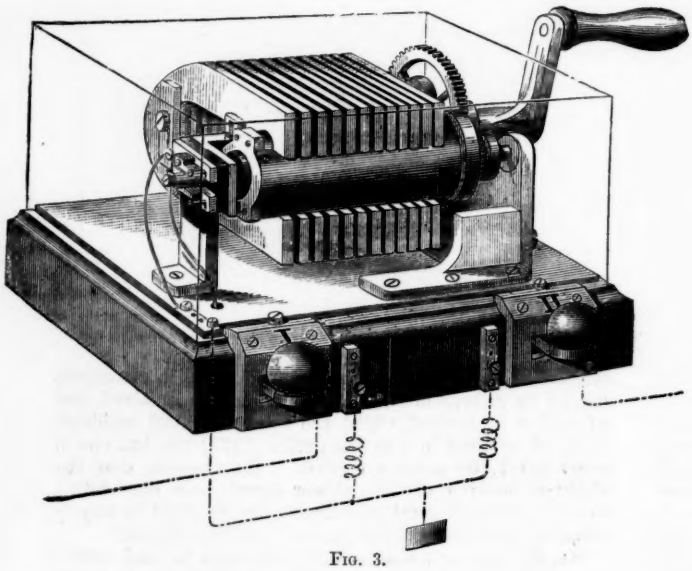


FIG. 3.

as it very rarely indeed became deranged, which could not be said of the Morse.

Mr. ALEXANDER SIEMENS drew attention to the fact that the Siemens gong system was designed for a special purpose, and that therefore it was absurd to criticise its value for other purposes for which it was never intended. He would mention that Messrs. Siemens had invented a signal system which was in use, and which was a visual system. The advantage of the Morse over the single needle instrument was that it gave permanent visual signals.

Professor AYRTON said that the use of magneto machines ought to be more extensive than it was at present. He said that a small machine could be made which would give an electromotive force of 700 volts through a resistance of 500 webers when turned by hand at 1,000 revolutions a minute. This result compared with the effects obtained from batteries was certainly very good. Both small dynamo and small magneto machines could be made. He would suggest

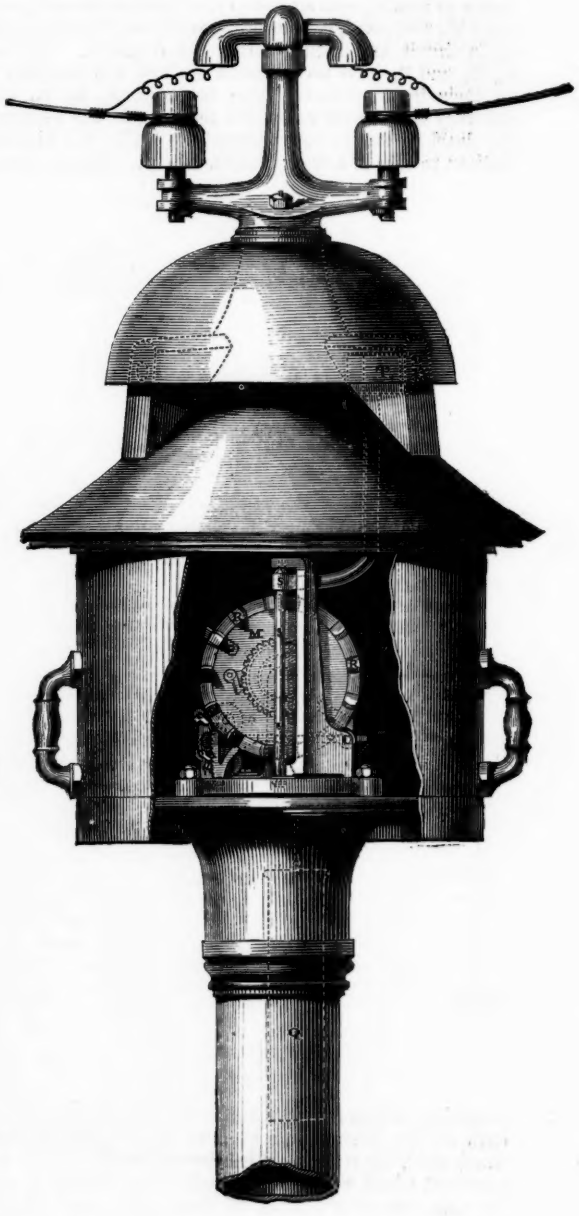


FIG. 4.

that the gongs in the Siemens system might be wound up by a small electro-motor attached to each gong, and kept in action by a weak continuous current kept on the line.

Mr. TREUENFELD in replying said that he thought that in speaking of the gong system he had explained that he only advocated its use for special purposes, and not in opposition to any existing block system, for which purpose, indeed, it was not intended. He contended that no English railway has a true block system, they all had simply systems by which the various signalmen were advised what

they were to do; whereas in a true block system the outdoor signals would be directly controlled by the action of the distant signalman. On the Continent there were quite 10,000 outdoor signals which were locked by electricity. With regard to Mr. Spagnoletti's query with reference to the expense of the gong system, he would point out that either gongs or bridges must be employed at level crossings, and of the two the gongs would be much the less expensive; these gongs were attended to by unskilled men at a low rate of pay. The winding of the clockwork presented no difficulty as the men invariably did it the first thing in the morning as a part of their daily routine. The clockwork would run for three days without being required to be rewound. As pointed out by Mr. Alexander Siemens, the use of the Morse as a receiving instrument was necessary, as it gave permanent visual signals.

The PRESIDENT, in adjourning the meeting, said that the only suggestion he had to make with reference to the gong system was that it might prove useful at points where the obscuring of signals by fogs was liable to lead to accidents.

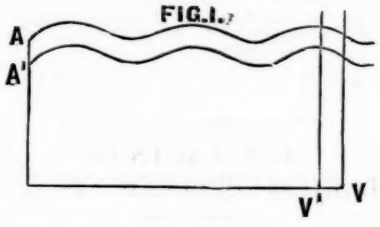
PHYSICAL SOCIETY.—FEBRUARY 25th.

Prof. G. C. FOSTER in the Chair.

New Members—Prof. G. F. FITZGERALD, Trin. Coll., Dublin; Mr. C. RICHARDSON; Lieut. H. J. DOCKRELL, R.N.; Mr. W. FORD STANLEY; General H. HYDE, R.E.; Mr. J. BUCHANAN.

Prof. AYRTON submitted certain observations which, along with Prof. Perry, he had made on Faure's accumulator. He said: The object of our investigation was directed to the purpose of finding—1st, The efficiency of the arrangement, *i.e.*, the amount of work that could be got out of Faure's accumulator compared with what was put in; 2nd, Its storing power; and 3rd, The lasting power—its ability to retain its charge. In order to measure the energy put into an electric circuit, all that it is necessary to do, as the members of this Society are well aware, is to measure the difference of potentials between the two ends of the circuit. Then the current in ampères × its difference of potential in volts × 44·25 is the number of foot-pounds of work per minute which is put into the cell. Now this energy is employed partly in producing chemical decomposition, and partly, of course, in heating the cell, and the amount of this latter depends on the rapidity with which the charge is performed. It is desirable, therefore, that in all experiments you should know how much energy is put into the cell usefully, and how much uselessly. In order to find out how much energy is put in usefully and how much uselessly, a very simple contrivance is adopted. While you are putting in your charge by means of a dynamo machine, or otherwise, the circuit is broken for a very short time—for a few seconds. The reading, then, on the voltameter is the real electromotive force of the cell at that moment, while the reading a moment before will show the difference of potentials produced partly by the cell and partly by the dynamo machine. From these data we can obtain how much energy is being wasted simply in heating the cell, because the discharge is too rapid. Or we can represent it graphically as a true curve with proportional ordinates for volts and ampères. Then of course, according to the law stated, A × V × 44·25 is the energy in foot-pounds, just

FIG. 1.



before breaking the current. But break it for a couple of seconds, and we have a new reading, A^1 V^1, with a new time curve, and the area (representing energy), *i.e.*, A^1 V^1 × 44·25, is less than before. The difference between these areas is of course the amount of energy which is put in uselessly in heating the cell. The lower area (*i.e.*, A^1 V^1) is the useful energy, and the difference is the useless energy in foot-pounds. In the same way, in the cell giving off energy, part of it is employed externally and part of it may be employed internally in heating the cell if the external resistance be small, or not very large compared with the internal resistance. The same mode of calculation as before shows the effective energy. The cell is discharged, a double current is measured, and the difference of potentials as read from the voltameter shows what fraction of the whole electromotive force is employed in sending the current through the external resistance. The same diagram as before adapts itself to this second set of circumstances; only in the case of the discharge v^1 is greater than v, whereas in the charge v^1 is less than v. We have made since last year a larger number of experiments; in fact, we have some 35 sheets of curves and the results. The first change to observe is this: that when you charge a Faure cell with a constant electromotive force, the charging curve is really like this.

FIG. 2.

It goes up and then it goes down. There is a slight increase of the resistance of the cell at the commencement, because if you draw the other curve, the A^1 V^1 curve, being close to this, it does not go up so much, and the two approach one another again. At first there is a certain amount of heat produced. On discharge, the same sort of thing occurs, only there is an increase of resistance towards the end of the discharge, so that, in fact, the falling off of the current towards the end of a long discharge is due far more to increased resistance than to any diminution of the electromotive force, which seems to be wonderfully constant, and the variations of current at the end appear to be really due to increased resistance. There is another very curious phenomenon in connection with the discharge of a secondary battery which is liable to mislead a person, and cause him to immensely underestimate the efficiency of the cell, and that is its marvellous resuscitating power. If you take such a battery, and apparently entirely discharge it—let the current get so very small that you can hardly measure it—it is an erroneous deduction to suppose that you have quite discharged it out. Wait a little, insulate the cell, and on re-testing it you will find that more energy is being given out than on its first discharge. Of course this is more marked with very rapid discharges, and in some instances of very rapid discharge we found that the number of foot-pounds of work given out after a certain time was two or three times the amount given out at the first discharge. Sometimes even this is the case when the discharge takes place for a very long period. In one case here we discharged a cell continuously for three days and nights, and when it was at length apparently totally discharged it was left insulated for a short time, and we found on commencing to redischarge that the number of foot-pounds of work was eight times as many as given off in the first discharge. In another case, before we realised the enormous resuscitating power which it had, we discharged a cell till the current was very feeble indeed. We then put it on one side, and to make quite sure for a new experiment that there was no charge left in it, we short-circuited it with a thick wire for half an hour. On returning to it we found that it was giving off ten times as much energy as before we short-circuited it, and how much had been lost in that operation we did not know. This extraordinary result shows how immensely important it is to be sure that you have thoroughly discharged your cell when measuring efficiency, and it requires considerable patience to render the discharge complete. It is obviously of immense importance in measuring efficiency to begin with an empty cell and end with an empty cell, and if an apparently empty cell has really 20 per cent. of charge left in it, it will vitiate all your conclusions. As to whether such a cell loses power largely, I in one case discharged a

cell for twelve days. Of course the current was not very large, but it went on discharging for that time. There was a considerable amount of energy wasted through short-circuiting, but in spite of that we got about 64 per cent. of the total charge put in, although we took twelve days to produce the discharge. The general efficiency seems to be this. That at any rate for charges up to one million foot-pounds, the total loss in charging AND discharging is not more than 18 per cent., *if* you have a current of about 17 ampères, not exceeding that. In some cases where the discharge is slower, we have found the total loss not to exceed much more than 10 per cent., of course taking great care that all the charge put in was got out.

It is more difficult to say what is the efficiency of such a cell if you are trying to charge it to its highest limit, because it is very difficult to be quite sure that you have not overcharged it—*i.e.*, that you have not wasted energy and got a wrong result by putting more energy into it than it will hold. I do not know what is the efficiency of maximum charges. The accumulator on the table before you is efficient with 82 per cent., certainly up to one million foot-pounds.

As to the storing power, this cell, with a charge of about as much as we could put in, gave out in 18 hours, with a current of about 18 ampères, 1,440,000 foot-pounds of work. This was on three successive days, it being insulated during the night. The cell contains about 81 lbs. of red-lead, so that that gives 18,000 foot-pounds of work per pound of lead.

The *resuscitating* power of such a cell as this is extremely surprising. In one particular case we had this cell discharging 61,440 foot-pounds of work in 18 hours. At the end of that time the current going off was so small that it was rather troublesome to read it. We put it on one side for some hours, and again tried it, and we found a current of 50 ampères going off. This point of resuscitating power is one of extreme interest and of importance when measurements are being made, and I would warn anybody making experiments not to be misled. Although you are most patient, and take three or four days to take a discharge from a Faure secondary battery, and at the end of that time find no measurable current, you must not jump to the conclusion that you have discharged the cell. If you will only leave it short-circuited for a few hours, you will find a large amount of energy still remaining. Let it resume discharging and take a reading—insulate it, and leave it for a short time and take another reading—before you proceed on the assumption that its energy is really spent.

Prof. AYRTON then described a new form of his dispersion photometer, which greatly reduces it in size and convenience. The principle of this instrument has already been described to the Society by the author. It consists in using a concave lens to disperse the stronger light, and thus obviate the necessity of putting it at a great distance if it is very powerful, such as an electric light. The powers of the two lights are compared by the eye in estimating the intensity of the shadows of a rod thrown on a white screen of blotting paper by the two lights simultaneously. A sperm candle is used as the standard, and it is placed on a movable stand at an angle to the path of the other beam through the lens. Both the lens and candle can be shifted to and from the screen along a scale giving their distances, and the stronger beam is reflected from a small mirror. This mirror is ingeniously fixed so as to reflect the ray from the same part of its surface whatever angle it is placed at, and thus the power of an electric light can be accurately given for every angle along which the ray travels from the lamp. Observations are taken through red and green glasses, to get a better measure of the power of the light. Prof. Ayrton has found that ordinary air absorbs the green rays of the electric light very strongly, and hence, in order to get a proper test of an electric lamp, the photometer should not be far from the light. The new dispersion photometer shown is the only one admitting of this precaution.

Mr. SHOOLBRED stated that he had found from experiment that the carbons of the Swan and Maxim incandescent lamps bore a much higher current without breaking when fed from a Faure accumulator than from a dynamo-electric machine.

Prof. AYRTON corroborated this statement, and said that he had obtained a light of 800 candles from a Maxim lamp fed by an accumulator.

Prof. SILVANUS THOMPSON then read a paper on the "Electric Resistance of Carbon under Pressure." It was generally stated that the resistance of carbon diminished under pressure, but he had found from recent experiments that the diminution observed was really due to the contact between the electrodes and the carbon. Under pressure there are more points of contact between the metal and carbon than without pressure. The result has an important bearing on the action of the carbon relay, rheostat, and microphone transmitter.

Prof. AYRTON pointed out that as carbon apparently diminished in resistance under a rise of temperature, this would seem to indicate it as a compound substance, since only simple substances seemed to increase in resistance with rise of temperature.

Prof. GUTHRIE recalled that Dr. Moser had suggested that the alteration of the resistance of selenium under light was an effect of contact.

A paper by Mr. G. GORE on the "Influence of the Form of Conductors on Electric Conductive Resistance." His experiments were designed to show whether there was a difference of resistance in certain liquid conductors under the positive and negative current. None was discovered.

Dr. HOPKINSON, F.R.S., read a paper on the "Refractive Index and Specific Inductive Capacity of Transparent Insulating Media." He inferred from tried experiments and the electro-magnetic theory that glass had a high refractive index for rays of very long wave length.

Dr. T. H. GLADSTONE suggested that the point should be tested by experiment, and that the method of photographing the red rays might be employed.

Mr. J. MACFARLANE GRAY explained that an objection to one result of his former communication to the Society on the "Specific Heat of Steam" was really a conformation of it, as Regnault's value was erroneous.

NEW PATENTS—1882.

856. "Generation, storage, distribution, regulation and utilisation of electricity, and apparatus or means therefor." J. S. WILLIAMS. Dated Feb. 22.

866. "Machinery for the manufacture of cables for telegraphic or other purposes." J. C. MEWBURN. (Communicated by La Société Alamagny et Oriol.) Dated Feb. 22.

869. "Dynamo-electric machines and apparatus connected therewith for lighting by electricity, and other purposes." C. E. SPAGNOLETTI. Dated Feb. 22.

872. "Electrodes or contacts for telegraphic or other electrical instruments." F. DES VŒUX. (Communicated by G. Cumming and C. M. Brinkerhoff.) Dated Feb. 23.

879. "An improved annunciator or indicator drop for telephone exchanges or the like." M. VOLK. Dated Feb. 23.

880. "Electrical signalling apparatus, especially intended to communicate the outbreak of fire." C. SPRATT. Dated Feb. 23.

898. "Electric arc lamps." J. BROCKIE. Dated Feb. 24.

902. "Manufacture of asbestos fabrics (for insulated conductors of electricity)." H. J. HADDAN. (Communicated by T. Trivier.) *Complete.* Dated Feb. 24.

905. "Secondary batteries." J. W. SWAN. Dated Feb. 24.

922. "Apparatus for transmitting and receiving audible signals by means of electricity." A. F. ST. GEORGE. Dated Feb. 25.

931. "Dynamo-electric machines." A. M. CLARK. (Communicated by H. B. Sheridan.) *Complete.* Dated Feb. 25.

933. "Compass correctors." J. J. WILSON. Dated Feb. 25.

941. "Improved arrangement of application for electrically controlling and regulating the speed of engines employed for driving dynamo-electric machines." J. RICHARDSON. Dated Feb. 27.

943. "Improved machinery for obtaining continuous or alternating currents of electricity." H. E. NEWTON. (Communicated by A. J. Gravier.) Dated Feb. 27.

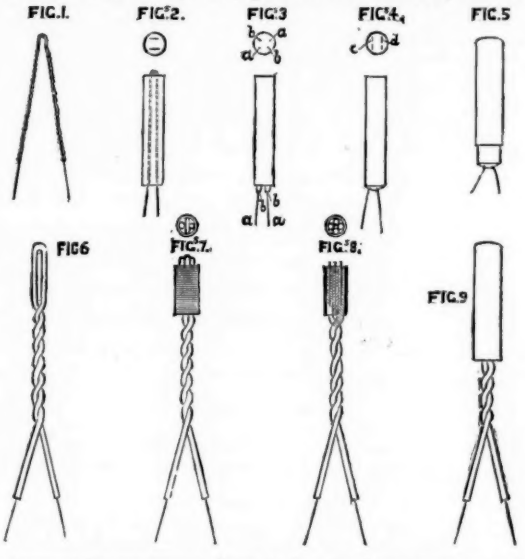
958. "Apparatus for cutting and reeling paper for telegraphic and other purposes." W. W. COLLEY. Dated Feb. 27.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

2482. "Electric machines," &c. E. G. BREWER. (A communication from abroad by T. A. Edison.) Dated June 7. 8d. In a system for supplying electricity from one source for a number of translating devices it is desirable that there be such an arrangement as will insure the generation of the proper amount of current, and the preservation of the proper pressure, no matter how many or how

few of the devices supplied in the system be in circuit, so that the amount of current requisite, and of the proper pressure or electromotive force be supplied to each device in circuit without regard to the increase or decrease of the total number in circuit. The object of a portion of this invention is to attain such result. One method of accomplishing this may be stated in general terms as consisting, where a special dynamo or magneto-electric machine is used for generating the current for the excitation of the field of force magnets, of one or a battery of generators connected to the main or consumption circuit in actuating such special generator, which may be termed the prime generator, by a special motor engine, to which it is geared directly, or from which it receives motion, and then governing this special motor engine so as to vary the speed of the special or field current generator by controlling its cut off mechanism by an adjustable governor, which operation proportionately varies the current sent through the field circuit of the one or battery of generators supplying the system, which in turn is followed by a proportionate variation in the generator capacity, while a constant electromotive force is maintained.

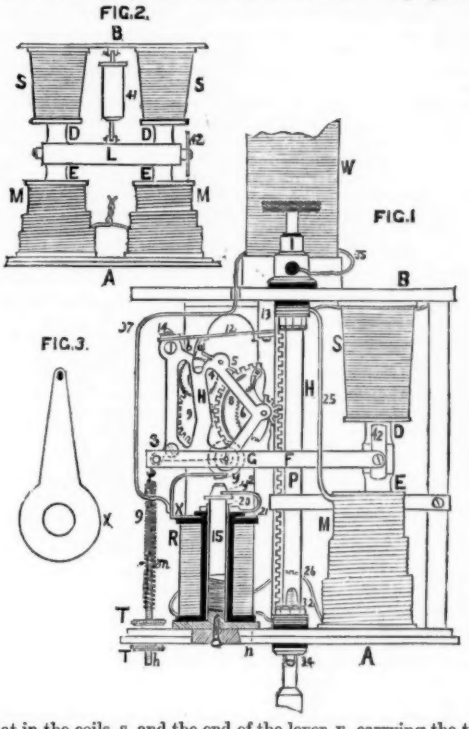
2826. "Electric fuses." DAVID JOHNSON and ERNEST SPON. Dated June 28. Has for its object the improvement of tension or spark fuses, so that they may be rendered more certain in their action and less liable to be effected by moisture or other causes which occasion the priming or fuse composition to be rendered inoperative. Figs. 1 to 5 show an advantageous method of carrying the invention into practical effect. According to this modification two wires are twisted together, as shown in fig. 1, an untwisted portion (say of about half an inch in length) being left in the centre of their length. The wires are then doubled over at the untwisted portion and inserted in a small tube of paper, metal, or other suitable material, as shown in figs. 2, the tube being then filled in with a composition of vulcanised india-rubber, celluloid, sulphur, cement, or other suitable insulating material, to form the body. When this is thoroughly hardened, the end nearest the loop of wire is filed smooth, and it will



then present the appearance shown in figs. 3, where *a* represents the main wires, and, *b*, the subsidiary wires for subdividing the sparks. The wires are then connected by means of a plumbago line, and the fuse as thus made is placed in circuit with a galvanometer, and the resistance caused by the plumbago line is then reduced to within any required limit by removing a sufficient portion thereof, and when the required resistance is reached the fuse is removed from the circuit. The plumbago lines are divided by drawing across them a sharp point so as to have a break at *c* and *d*, as shown in the plan of figs. 4, and the fuse is thus caused to be mechanically sensitive and very effective, especially for use with magneto or dynamo-electric machines. Fig. 5 represents an outside elevation of the fuse inserted into a case containing fuse composition. Another modification of the invention is illustrated in figs. 6 to 9. According to this modification, which is especially suitable for use with frictional electric machines, there is placed within the loop of two twisted insulated wires, as shown in fig. 6, a small piece of wire or other substance which will serve to keep them a little distance apart, and on each side of this is placed a small piece of insulated or other wire, and the whole is tied together, as represented in fig. 7. The tied end is then transversely cut, so as to leave the ends or points of the wires separated, as shown in figs. 8; this then forms the fuse head, and may be inserted into a cap of paper, wood, metal, or other suitable material containing priming composition, as hereinbefore described, the whole being shown complete in fig. 9.

2851. "Electric lighting apparatus." W. R. LAKE. (A communication from abroad by J. J. Wood, of New York.) Dated June 29. 6d. Relates to improvements in electric lighting apparatus, and comprises an arrangement of circuits and devices designed to afford a conducting path around a faulty lamp when from any cause, such as breakage of the carbons, or failure of the regulating mechanism to act properly, the resistance in the light or carbon circuit rises above a regulated or determinate amount, thus interfering with the proper action of other lamps in the same circuit. Fig. 1 represents a side view of a lamp according to the invention, a portion of the frame being removed and the switch-magnet being shown in partial section.

Fig. 2 is an end view of the axial electro-magnets in the main and derived circuits, and their moving cores. Fig. 3 shows the form of a blank used in forming the circuit-closing point attached to the end of the axial electro-magnet in the main or light circuit which controls the branch safety circuit. The general operation of the lamp is as follows:—While the arc is of the proper adjusted length the current divides between the helices, M, M, and S, S, in the inverse proportion of the resistance of the circuits in which they are placed. The resistance in the coils themselves and their circuits is so proportioned, and the spring, *g*, is adjusted to such a tension, that the attractive effect in the coils, M, will under these circumstances preponderate



over that in the coils, S, and the end of the lever, F, carrying the train will be held in an elevated position with the wheel, 4, in engagement with the detent, *b*. The carbon-carrier, rack, and connected gearing are thus held from movement. The core, 15, of the coils, R, in the carbon circuit is also held down against the action of the coiled spring upon which it is seated, and the branch or safety circuit in which the resistance, W, is included, is broken at the points, y^1, y. As the carbons burn away the resistance at the arc increases and the attractive force in the coils, M, decreases, while those of S correspondingly increase, and as a consequence, the end of the lever carrying the train is gradually drawn down by the action of the retracting spring, *g*, thereby gradually lowering the train and the connected carbon-carrier until the detent, *b*, and the wheel, 4, are disengaged. The connected gearing is then free to rotate by the action of the gravitating carbon-carrier, and the upper carbon is carried downward towards the lower one until the arc is shortened and the resistance so far lessened that the coils, M, again draw down the lever, and bring the toothed wheel and detent into engagement with each other. Should the current strength in the general circuit increase, the arc will be correspondingly lengthened, the cores, R, being drawn further within the coils, M, thereby still further raising the releasing train. To this action the detent opposes no fixed obstacle, since it is attached to the yielding spring. In case the upper carbon fails to free itself by reason of sticking in the gearing, the carbons would gradually consume and the circuit become finally broken, thus interfering with the action of other lamps in the same circuit. To provide for this and other contingencies, such as breaking of the carbons, the switch-magnet, R, is placed in the main or light circuit. So long as the proper action of the arc continues the branch or safety circuit is broken, but upon the breaking of the light or carbon circuit, or the occurrence of an abnormally great resistance, the coils, R, cease to exert a sufficiently attractive effect upon the core, 15, to hold it depressed. The coil-spring thereupon raises the core into contact with the point, *y*, and gradually the branch or safety circuit through the resistance coil, W, is closed. If the difficulty arises from breakage of the carbons, or from a sudden and marked decrease in current strength in the general circuit, the carbons will be gradually fed until they come into contact and re-establish the main or light circuit. The coils, M, will thereupon act to raise the train and upper carrier to re-form the arc, and simultaneously the coils, R, will act upon the core, 15, and break the branch or safety circuit. The electro-magnetic switch, R, acts with certainty and promptness, owing to the fact that it is in the main or light circuit, and is subjected to the action of the current passing through the arc. It requires but few convolutions of large-sized wire, a circumstance that facilitates the construction and lessens the cost. The axial magnet is preferred in this connection as it is compact, and requires no extra attachments to the frame as the ordinary form does, so that the general appearance of the lamp is not marred. Other forms of electro-magnet may, however, be employed if desired.

CITY NOTES.

OLD BROAD STREET.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

THE 18th ordinary meeting of the above Company was held at their offices, 38, Old Broad Street, London, E.C., on Tuesday afternoon last, the Chairman, Sir Daniel Gooch, Bart., M.P., presiding.

Mr. Shuter, the manager, having read the notice convening the meeting, the minutes of the last ordinary meeting were read and approved, and the report and accounts were taken as read.

The Chairman said: "I would merely upon this occasion call your attention to a few figures in the report before you, which already, I daresay, you have in your mind. The accounts for the past year show a net profit of £72,299 12s. 8d., and we brought from the previous year £77,735 0s. 1d., making altogether a total of £150,034 12s. 9d. at your disposal. We have paid a dividend of 20 per cent. during the year, leaving a balance for the next year of £60,394 12s. 9d. I hope you will consider that very satisfactory working for the year (hear, hear). The work that we have been doing during the past year is not so large as in former years. The Western and Brazilian Telegraph Company was supplied with 200 miles of cable, which was carried to Brazil by the steamship *Kangaroo*. We have repaired the French Atlantic Cable during the year, manufactured 537 miles of cable for the Eastern Extension Company, laid it between Singapore and Batavia, and also picked up some of the old cable—as much as we could get. Paragraph D of the report refers to the shore ends of the cable between Emden and Valentia, 840 miles of the intermediate portion of the cable we are now making, and that will be laid in the course of April next. 550 miles of cable between Corfu and Trieste have been made and laid, and in fulfilment of our contract with the South African Company we have finished all the buildings connected with the landward portion of their lines. We are also now engaged on repairs for the German Union line. The report states that all machinery, ships, &c., are in good working condition. The ships we have, as you know, are the *Scotia*, which is to go out with 840 miles of cable to be laid between Emden and Valentia; the *Seine*, which is on her way home after laying the Singapore cable; the *Kangaroo*, which has just left with the Western Brazilian piece of cable; and the *Calabria*, which has been employed twice during the year by the Government in carrying troops, and which has done her work very satisfactorily for them. The accounts are set forth, as you will see, in full detail as usual, and I shall be very glad to answer any question in regard to either those in the report or any other point on which any shareholder wishes for further explanation. I have not much more to say to you, except that I hope that we shall be able to continue in the prosperity which has hitherto attached to our company. I should be very glad to answer any question. I have to move that the report and accounts of the directors up to 31st December, 1881, submitted to this meeting, be, and the same are hereby received and adopted, and a dividend of 36s. per share, in addition to the 12s. already paid, free of income tax, be declared.

Sir George Elliot, Bart., M.P., seconded the motion.

Mr. Wakefield said: Mr. Chairman, I waited for larger shareholders to say a few words, but as no one has done so—I have been a shareholder for some time, and still hold some considerable stake in the company, so that I know it will be for my edification, and likewise I dare say for that of some of those in the room, to have a few words of encouragement from you as to the future. As you are aware, there was at one time a great fall in our shares. A good deal of that was to be set down to Stock Exchange rumours; yet, at the same time it did frighten some of the older shareholders into parting with their shares, and at the time it seemed as if they would be right in doing so, for there was a fall of £7 or £8 per share. The report was that we were getting not nearly so much work as we had had in previous years, and I am quite sure that was not the fault of the directors or those who were responsible for the management of our concern, for, as we all know, a great deal of energy has been exercised by them; but, still it must strike us all that a time may arrive when there may be less work in laying telegraphs, because lines may be laid to most places, and they will not break sufficiently often for the purpose of our company to replace them; and therefore I would ask you whether in the future we have a prospect of much more work to do? Of course, as this has been so prosperous a company, there will be opposition; we must expect it, and we know that in one quarter already we are pressed a good deal. These people have undertaken the work, and we cannot see that it will pay them. But they did so in order to obtain a prospect for their manufactures. They manufacture cheaper than we can; the telegraph lines can certainly now be laid down at much less expense than they have been, and smaller, and therefore less expensive, cables will do; so that with all these things I should be glad if we can have some explanation as to whether we can go into any other business—whether our works are fit for any other business. There is a great talk just now about electric lighting, telephones, and things of that sort. Can we do anything in that way, so that even if less is done in our legitimate business we shall be still able to keep the market going in some of these new inventions?

The Chairman: We are unable to prophesy the future of telegraphy, but no doubt there will be a great many cables laid. I think that many do require yet to be laid. Businesses of this kind, like all other businesses, must be subject to some fluctuations. We have had that in the past history of the company, and I do not know whether we shall not be subject to that in the future. The opposition spoken of is not a new thing, it has been going on for several years. What opposition there is, we have fought our way through, and I hope we shall fight our way through it in the future, and we may with safety say that our cables, as far as they have been laid, have given every satisfaction to the companies for whom we have laid them. We have officers and staff skilled in laying cables, and have always done our work without delay or accident. The ships have been our own. I do not know that that can be said of all the other cables. As to the other business spoken of, we, of course, are doing a good deal of business, both laying cables and, as you know, having a large gutta-percha works in operation, and also contracting for a considerable quantity of these lines for electric lights (hear, hear). I have no doubt of the extension of our gutta-percha manufacture. As to the future there are many here as able to judge or form an opinion as I am, perhaps better able, but at all events whatever work there is to do we will do our best to secure a fair portion of it for ourselves. Cables are being constructed more cheaply, and we are able to construct more cheaply in consequence of our increased experience and knowledge which we have obtained by many years' acquaintance with the work, and I hope we shall always be able to make our cables, and guarantee them when laid as efficient and good cables, and we shall most likely obtain a good deal of other business in the future. Mr. Wakefield spoke of lighter cables being made. The feeling amongst those who have the management of cables is rather in the other direction, that cables should be heavier instead of lighter, because they cannot be recovered when they are light. That is a very important feature indeed, and they are now made stronger rather than lighter, that is the feeling of those who have the management of cable companies.

The motion was then put to the meeting and carried unanimously.

The Chairman moved that Sir George Elliot, Bart., M.P., be re-elected a director of the company. Philip Rawson, Esq., seconded the motion, which was carried unanimously.

The Chairman further moved that Philip Rawson, Esq., be re-elected a director, which was seconded by Vice-Admiral Sir George H. Richards, and also carried.

Mr. Abbott begged to move that Mr. John Gane be re-elected as an auditor of the company at a remuneration of £150. Mr. Wakefield seconded the motion, which was carried unanimously.

Mr. Abbott also moved that Mr. James Glegg be re-elected as an auditor at a similar remuneration, which was also seconded by Mr. Wakefield, and carried unanimously.

On the motion of Mr. Wakefield a vote of thanks was awarded to the chairman and the board of directors, and the proceedings terminated by the Chairman returning thanks, and calling attention to the fact that coupons of the Second Bonus Trust (paid as part dividend to shareholders on the Register in February, 1875), to the extent of about £450 had not been presented at the Bank. There had been 13 Distributions on Interest and 1 on Capital Account. On this latter there was a balance of £6,000 still unapplied for.

LATEST QUOTATIONS.

Authorised Issue.	Shares.	Name.	Paid.	Closing Quotations. March 1.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	4	8¼ - 9	8⅝
		Do. Do.	10	21 - 22	
150,000	1	Electric Light and Power Generator Co.	1	¾ - 1	⅞
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	48 - 49	47½
2,441,800*l.*	Stk.	Do. Preferred Def'd. receiving no div. until	100	76½-77¼	76¼,76½,77,77½,77¼,77⅛
2,441,800*l.*	Stk.	Do. Deferred 6 p. c. has been paid to Pref.	100	19 - 20	19½
130,000	10	Brazilian Submarine, Limited	10	11 - 11½	11½
16,000	10	Cuba, Limited	10	8½ - 9	
6,000	10	Do. 10 per cent. Preference	10	15½ - 16½	
13,000	10	Direct Spanish, Limited	9	5½ - 5⅝	
6,000	10	Do. 10 per cent. Preference	10	14½ 15½	
65,000	20	Direct United States Cable, Limited, 1877	20	.. ..	
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	100 -103	
380,000	10	Eastern, Limited	10	9⅝ - 10¼	9 15/16
70,000	10	Do. 6 per cent. Preference	10	12⅝ - 12⅞	
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	99 -102	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	102 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	10⅝ - 11¼	
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	105 -109	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	101 -104	
140,000	100	Do. do. registered, repayable 1900	100	101 -104	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300*l.*	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan. 1900	100	100 -103	
345,700*l.*	100	Do. do. To Bearer	100	100 -103	
22,050	10	German Union Telegraph and Trust, Limited	10	9½ - 10	
163,390	10	Globe Telegraph and Trust, Limited	10	5¾ - 6¼	6.5 15/16.6
163,209	10	Do. 6 per cent. Preference	10	11¼ - 12¼	
125,000	10	Great Northern	10	11½ - 12	
100,000*l.*	100	Do. 5 per cent. Debentures	100	100 -103	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	23 - 24	
100,000	100	Do. 6 per cent. Debentures, 1886	100	104½-106	
17,000	25	Indo-European, Limited	25	28 - 29	
38,148	10	London Platino-Brazilian, Limited	10	4¾ - 5¼	
12,000	10	Mediterranean Extension, Limited	10	2½ - 3	
8,200	10	Do. 8 per cent. Preference	10	9 - 9½	9
9,000	8	Reuter's, Limited	8	12½ - 13	
280,000	Stk.	Submarine	100	265 -275	
58,225	1	Do. Scrip	1	2¼ - 2½	
4,200	Cert.	Submarine Cables Trust	100	97 -100	
37,350	12	Telegraph Construction and Maintenance	12	27½ - 28¼	28¼ xd.
150,000	100	Do. 6 per cent, Bonds, 1884	100	101 -105	
186,750	5	Do. 2nd Bonus Trust Cert.	5	1⅛ - 1⅜	
30,000	10	West Coast of America, Limited	10	4½ - 5	
150,000	100	Do. 8 per cent. Debentures	..	.. ..	
69,910	20	Western and Brazilian, Limited	20	8⅝ - 8⅞	8 11/16,8 13/16,8 7/8,8 1/16
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	105 -110	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	98 -101	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	123 -128	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	103 -104	
88,321	10	West India and Panama, Limited	10	1¼ - 1½	1⅜,1 11/16
34,563	10	Do. 6 per cent. 1st Preference	10	7⅛ - 8	
4,669	10	Do. 6 do. 2nd do.	10	6 - 6½	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	1¼ - 1½	1 7/16
200,000	1	Oriental Telephone Co.	½	¼ - ⅜	7/16
100,000	5	United Telephone Co.		12½ - 13¼	13¼,¼